

Project: Fire Station Add/Alter, B3321

Capital Project #1039839

Date: January 2024

CONSTRUCTION SPECIFICATIONS



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SECTION 010100 – GENERAL REQUIREMENTS

1. **SCOPE:** The work covered by this project consists of the Contractor furnishing all labor, supervision, quality control, transportation, materials, equipment, machines, tools, appliances, services, supplies, incidentals and performing all operations in connection with the "Fire Station Add / Alter, B3321 project, Goodfellow AFB, Texas, complete and in strict accordance with the plans and specifications.

1.1 PROJECT DESCRIPTION:

B3321 is the primary Fire Station serving Goodfellow AFB, and originally built in 1995. The scope of this project includes the construction of a new 8-person, single story dorm facility, complete with new restrooms, showers, utility space, and a connecting breezeway to the existing Fire Station. It also, includes the alteration of the existing sleeping quarters within B3321. Refer to plans and specifications.

1.2 PROJECT LOCATION:

Goodfellow Air Force Base is located in Tom Green County, on the southeast side of San Angelo, TX. and is bounded to the north by Highway #388 (Paint Rock Rd.), to the west by Fort McKavett Rd and Christoval Road, to the south by Highway #1223 (San Antonio Hwy.) and to the east by the eastern city limits. The primary work location for this project is adjacent to B3321 Fire Station, located near the corner of Vance Street and Kearney Challenger Avenue.

1.3 AGENCY RELATIONSHIP:

Tom Green County (TGC) has sole contract authority. 17th Civil Engineer Squadron (17 CES) Goodfellow AFB will serve in the role of providing contract coordination/monitoring but will not have any direct contract authority to approve or disapprove construction work. All on site construction work will be monitored and inspected by GAFB 17CES. All contract correspondence shall be directly submitted to TGC contract representative. Note, all on site construction work is unclassified and no security clearances are required. This project is funded by the Texas Military Preparedness Commission in the form of the Defense Economic Adjustment Assistance Grant (DEAAG) with State and local matching funds; Substantial Completion must be completed (including establishing the Punch List and completing the Base Checklist) no later than 01 November 2024.

Final Close Out (Including O&M Manuals, As-Built redlines, and Punch List) must be completed and invoices approved no later than 01 November 2024 to utilize all funds provided by the Grant, unless time extension has been provided by TGC. In the event construction has not been complete, the contract may be terminated or the scope amended. There shall be neither penalty nor any additional charges incurred by Tom Green County (TGC).

1.4 PERIOD OF PERFORMANCE:

Work to be performed for this project shall be as indicated in the specifications and described on the plans. The total project Period of Performance for Base Bid, Phase 1, shall be 365 calendar days. The total project Period of Performance for Option Bids #0002a, #0002b, #0002c, if awarded, shall be 180 calendar days. Option Bids #0002a, #0002b, #0002c correspond with phase 2a, 2b, and 2c listed in the section 1.5 "Phasing Plan". Total project Period of Performance for Base Bid and all Option Bids, if awarded, shall be 545 calendar days. For additional information, refer to Bid Schedule.

1.5 PHASING PLAN:

1.5.1 Phase 1: Work consists of the construction of the new firefighter dorm with all items and appurtenances necessary to have a complete and functioning facility as described in the specification and on the plans. To include but not limited to, civil, structural, architectural, mechanical, electrical, plumbing, telecommunications, and fire protection systems.

1.5.2 Phase 2a, 2b, and 2c: Work consists of the renovation of the existing firefighter sleeping quarters in the Fire Station, B3321, as described the specifications and on the plans. To include architectural, mechanical, electrical, telecom, fire protection, and removal and reinstallation of furnishings.

Base Bid and [Option Bid] work are subsequentially phased. If Option Bid, Phase 2a, 2b, or 2c, work is awarded, no work shall commence until full construction of all Phase 1 work including move-in is complete and has been accepted by TGC and Government representatives. Firefighters will fully relocate and occupy new dorm prior to start of Phase 2 work. At any time, no more than one Phase of construction can occur. Goodfellow AFB will be fully responsible for relocation of Goodfellow AFB personnel (firefighters) move-in and installation of all dorm furnishings.

NOTE1: If Phase 2a, 2b, or 2c, Option Bids are awarded, the Contractor shall coordinate with TGC and GAFB representatives for each phase of the alteration/renovation portion of the project. (Phase 1 to Phase 2a, Phase 2a to 2b, and Phase 2b to 2c). Also, during this time, the Contractor shall perform such tasks as compiling submittals for approval and/or information, ordering materials to be available for the actual construction work including performing site surveys, materials surveys, ordering long lead-time items and verifying dimensions. The Contractor shall also procure and stage storage containers for the removal and storage of existing furnishings that have remained once all personnel have vacated the existing sleeping quarters in B3321. Refer to Note2 below. The Contractor shall have full access to the facility, but no actual new work or demolition shall be permitted during this period except installation of all temporary partitions. The Contractor shall perform no new work or demolition for this project during the transition period, unless otherwise noted.

NOTE2: Phase 2a, 2b, or 2c: Furnishings Moving/Storage/Reinstallation (IF APPLICABLE)

If Phase 2 Bid Options are awarded, the Contractor shall move/transport/off-load all furnishings to an approved designated Contractor provided storage. The Contractor shall be responsible for moving and protection of all furniture and other items, exclusive of electronics, training equipment, and personal items. Furniture includes but is not limited to beds, bedding, lockers, window treatments, fans, etc. The Contractor shall with the 17 CES representative perform an exit inventory for all room furnishings (itemized per room) and make note of any large scratches, dents, missing hardware, and other existing defects. The Contractor shall protect from damage and keep clean all items all items inventoried and stored. Damage caused to furniture or other TGC property as a result of Contractor operations shall be repaired or replaced at no additional cost to the TGC. Contractor shall replace/repair all furniture to its original condition unless directed otherwise by the Contracting Officer. The Contractor shall with the 17 CES Designated Representative perform a return inventory of all storage furnishings and other items using the previously completed exit inventory documentation. Refer to Attachment for complete list of furnishings scheduled for moving.

Upon completion of each Phase 2a, 2b or 2c work (if awarded), the Contractor shall remove and reinstall all furnishings. There is no existing on-base available storage. The Contractor shall not move/return any furnishings until after completion of the final inspection of each Phase. The Contractor shall return/move/transport/off-load/install all furnishings to building 3321. The delivered/return furnishing locations shall be within facility B3321 IAW the new room schedule.

Moving, replacement, disassembly, and re-assembly of all furnishings including systems furniture shall be accomplished by firms or persons possessing prior experience in this field of expertise. The Contractor shall have either the required experience or a firm agreement with a Sub-Contractor who possesses the required experience. Under no circumstances shall any demolition occur until all moving by the Base Fire Station personnel has been completed.

2. WORKING CONDITIONS:

2.1 WORK AND MECHANICS:

The work for this project shall be executed in the best and most workmanlike manner, by qualified and efficient mechanics/tradesmen, skilled in their respective trades. Only certified journeymen in each respective trade, or apprentices under the direct supervision of certified journeymen, shall be permitted to install and/or supervise installation for this project. Individual trade work for this project shall be performed and quality maintained by the applicable trade, only. All trades shall coordinate their work with that of other trades. The Contractor shall coordinate and perform all operations in a manner that will result in a professional and expeditiously completed project. The work shall be in strict accordance with prevailing industry standards and manufacturer's instructions.

2.1.1 FIRST WORK: The Contractor, prior to of work shall be responsible for providing proposed location, via AF Form 3000, a site plan showing the location and dimensions temporary facilities, to include, office trailer, lay-down area, construction fencing, dumpster (if necessary), temporary sanitary facilities, personnel parking, and ensure that there are "No" disturbance with any emergency services. The site plan shall include access and haul routes, avenues of ingress/egress to the project site. Also, the Contractor shall commence on providing construction related submittals as described in Project Documents: AF Form 66 Submittal Register. This register does not include additional specifications-related submittals that will be required of the Contractor upon completion of the project. The Contractor shall also ensure that all entry control, security, and safety measures in and around the work site are in place, see Project Drawings.

2.1.2 TEMPORARY FENCE: The Contractor shall fence-in and secure the work site and lay down area. This area shall provide for office space, equipment, and material storage. New materials shall be secured, protected, and placed on dunnage. At no time will new materials be allowed to be placed on bare ground. This fence shall be minimum 6'-0" high portable chain link with portable interlocking panels, pedestrian gate(s), and/or vehicular gate(s). Fencing shall be maintained by the Contractor throughout the life of the contract. Temporary fencing shall be secured with sandbags due to expected high winds in the project work area. Temporary fencing used by the Contractor to delineate construction sites shall be securely anchored with tension wires and posts as required to prevent sagging and an unsightly appearance. Any existing site improvements altered by the presence of the fence shall be restored to their original condition and appearance. Due to high winds in West Texas, Contractor shall take every precaution to preclude trash and materials from blowing off site. If the Contractor requires additional outside storage space, they shall contact the Contracting Officer with a written request to include a single-line site plan diagram with specific dimensions. Note there is no existing on-base building storage space.

2.1.3 FACILITY ACCESS: Phase 1 Facility Entry/Egress: The entry/egress locations for B3321 will remain unchanged with exception of east main entry door as shown on project drawings. All building fire exit/egress doors shall be maintained/functional at all times.

Phase 2 Facility Entry/Egress: Contractor shall maintain a temporary construction access lock on the exterior exit door nearest the southwest entrance of the existing fire station. The Contractor shall coordinate with Goodfellow AFB Locksmiths for construction core and key prior to start of work. Refer to project drawings for exit location. The doors shall remain locked during Phase 2 work. Contractor shall provide temporary partitions to prevent occupants from walking through ongoing construction sites and shall provide all necessary physical barriers and visual signage identifying Contractor work areas. The Contractor shall not alter exterior doors in any manner that would preclude use as emergency exit. The Contractor shall maintain keys issued by 17 CES for those doors and shall return keys upon Phase 2 construction completion.

2.2 WORK SCHEDULE:

Working hours for the Contractor will normally be between the hours of 7:30 A.M. and 4:30 P.M. excluding Saturdays, Sundays, Federal holidays, and days designated as "Family Days" by Air Education and Training Command (AETC). See the table below for reference for the 2023-2024 dates and refer to Section H of the solicitation/contract document for further information on working days. Any holiday falling on a Saturday will be observed the preceding Friday. Any Holiday falling on a Sunday will be observed the following Monday.

If the Contractor desires to work during periods other than above, a request must be made to the Contracting Officer in writing three (3) calendar days in advance of his/her intention. If the required base personnel are reasonably available, the Contracting Officer may authorize the Contractor to perform work during periods other than normal duty hours/days. The Contractor shall not be permitted to perform work after 1900 hours in the evenings, to 0600 in the mornings without written approval from the Contracting Officer.

Federal Holiday	2023		2024	
	Holiday	Family Day	Holiday	Family Day
New Year's Day	02 Jan	-	01 Jan	02 Jan
Birthday of Martin Luther King, Jr.	16 Jan	-	15 Jan	-
Washington's Birthday	20 Feb	-	19 Feb	-
Memorial Day	29 May	26 May	27 May	24 May
Juneteenth Nat'l Independence Day	19 Jun	-	19 Jun	-
Independence Day	04 Jul	03 Jul	04 Jul	05 Jul
Labor Day	04 Sep	01 Sep	02 Sep	30 Aug
Columbus Day	09 Oct	-	Oct 14	-
Veterans Day	10 Nov	-	Nov 11	-
Thanksgiving Day	23 Nov	24 Nov	Nov 28	29 Nov
Christmas Day	25 Dec	26 Dec	Dec 25	24/31 Dec

The base could be closed because of security problems, adverse weather, or other events. Unless otherwise notified by the Government, the Contractor should monitor local television stations, radio stations, or Goodfellow's Facebook page for notification of a possible base closure or late opening. The Contractor may not receive any other form of notification of a base closure from the Government, unless contacted by the Contracting Officer (CO) or the COR.

The Contractor is responsible for notifying his/her employees. Contractor(s) do not report when the base is closed due to security problems and/or adverse weather.

2.3 TOBACCO USE IN AETC FACILITIES

Contractors are advised that the Commander has placed restrictions on the smoking of tobacco products in AETC facilities. AFI 40-102, Tobacco Use in the Air Force, outlines the procedures used by the commander to control smoking in our facilities. Contractor employees and visitors are subject to the same restrictions as government personnel. Smoking is permitted only in designated smoking areas. Additional information, to include locations of designated smoking areas, will be provided to the contractor at the pre-performance conference.

2.4 OPERATIONS SECURITY (OPSEC) REQUIREMENTS

Not Required

2.5 BASE ACCESS:

2.5.1 BASE ACCESS REQUIREMENTS:

Goodfellow Air Force Base is a closed/controlled access base. The Government will conduct security/background checks on all construction personnel as required. Requirements are subject to change dependent upon current world situations, potential threats, and base exercises. Contractor should anticipate certain notification and reporting requirements, preparation of forms, and lists for pass and identification of employees and their vehicles, entry restrictions, key/lock control, and compliance with all base traffic rules and regulations. The Jacobson Gate Visitor Control Center 325-654-4122 is the primary point of contact for passes.

2.5.2 INSTALLATION ACCESS PASS:

Before arrival, a government card-holding person will submit a request for base access using the 17 Training Wing's Base Access List (BAL) memorandum as a form of registration for each applicant. The BAL will include pertinent visitor information, reason for entry, frequency of entry, destination, times each day requiring entry, and duration of request.

2.5.3 ACCESS DENIAL:

If it is determined a Contractor requesting access has been convicted of a felony or pled guilty to a felony charge within the past 10 years, or is considered not fit to obtain authorized access based on the information obtained during the identity vetting, or criminal history indicates the individual may present a threat to the good order, discipline and morale of the installation, Security Forces personnel will deny entry. The Contractor will be informed of the access denial, will be issued an Access Denial Letter, and will be informed on how they may appeal this order.

2.5.4 DENIAL APPEAL PROCESS:

When denied access, contract visitors will be informed to report back their manager. If the contract worker and management are considering an appeal, it will be submitted by letter to the 17 SFS Commander, within 30 days of access denial. The 17 TRW/CC will approve/disapprove all appeals for entry.

2.5.5 ABNORMAL WORK SCHEDULE:

For access on non-duty hours or down days:

- a.) Identify which workers need access for times not listed in 2. WORKING CONDITIONS.
- b.) Ensure only workers that are already vetted are on the Extended-Hours request (no new personnel).
New personnel require a new BAL and formal vetting.
- c.) Complete the "After Hours" BAL for workers requiring down day access to the installation.

If deliveries are not made during the operational hours listed in the paragraph 2.2 WORK SCHEDULE, the request may be declined.

2.5.6 PASS HANDLING:

All BALs have a duration not to exceed 180 days. When an employee is no longer employed by the Contractor or Sub-Contractor, all ex-employee passes are to be returned to the Government. If an issued pass is not returned, the Contract Officer may withhold funds, or the Installation Commander may consider debarment to the installation.

2.5.7 TRAFFIC LAWS:

Contractor and employees shall comply with Texas transportation code, base traffic regulations and posted signs while on the installation.

2.5.8 WEAPONS, FIREARMS, AMMUNITION:

Contractor employees are prohibited from possessing weapons, firearms, or ammunition on themselves or within their contractor-owned vehicle or privately-owned vehicles while on base.

2.5.9 IDENTIFICATION OF CONTRACTOR VEHICLES:

Contractor vehicles should be marked on each side with company name with either permanent or semi-permanent/magnetic signage to aid the Security Forces in identifying and permitting them exemption from basewide exercises.

2.6 UTILITY CONSERVATION:

The Contractor will be required to participate in government energy conservation programs. For the purpose of this contract, utilities such as water, electricity, etc., will be furnished by the government at no cost to the contractor. Long distance and Defense Switched Network (DSN) telephone services will not be provided.

2.7 WORK AREA ACCESS:

The work area is positioned between the existing GAFB SFS, B3323 to the East and the existing GAFB FD, B3321 to the West. Base Security Forces (Police) and Base Fire operations are a 24/7 year-round operations that shall remain occupied and in operation at all times in order to provide base emergency service support to the GAFB installation through the life of the contract. At all times, emergency vehicles, fire and police, must have immediate ingress and egress access to Police and Fire Stations. The Emergency Control Center (ECC) is located in the Security Forces building, under no circumstances shall communication lines be terminated. No Government escorts are needed in this area. B3321 Fire Station.

2.8 SITE VISITS:

The Contractor may visit the premises to become thoroughly familiar with details of the work and working conditions, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before starting the work.

3. SPECIAL CONDITIONS AND PERMITS:

3.1 BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST:

The Contractor shall obtain and process AF Form 103 for approval prior to commencement of work for this project. The Contractor shall always have the completed form on site.

3.1.1 PROCESSING AF FORM 103: Due to the requirement for multiple agencies to coordinate on these requests, expect 14 days for paperwork processing. Contractor requests should be submitted at the earliest possible date to preclude delays.

3.2 UTILITIES:

Approximate location of existing utilities has been provided in the attached Project Documents. Utilities shown are approximate and meant for Contractor reference and bidding purposes. The Contractor shall take reasonable precautions in determining the exact location of all existing utilities within the contract work area prior to any excavating, trenching, backfilling, or disturbance. Upon request by the Contractor, the Government will provide all available information in its possession concerning utilities in the contract work area. Contractor shall hand dig around gas/water utilities.

3.2.1 UTILITY OUTAGES: When a utility outage is necessary to perform the contract work in an occupied facility, regardless of whether the work area is occupied, the outage shall be performed by the Contractor during non-duty hours at no additional cost to the Government, unless otherwise approved by the Contracting Officer. The Contractor shall notify the Contract Inspector of outage requirements to include buildings affected; length of outage; and reasons for outage. The Contractor must allow affected occupants a minimum of two – (2) weeks notice prior to outage. The Contractor is also required to provide the Contracting Office a written notification of the requested outage.

3.2.2 ACCIDENTAL UTILITY DISRUPTIONS: In the event of accidental disruption of any utility, the Contractor shall immediately notify the Contracting officer of the unplanned outage. After reporting it to the Contracting Officer, call Civil Engineering (325-654-3436) to inform them of an outage with what type of utility you may have encountered.

The Contractor shall immediately take every reasonable step to repair the damage in a manner acceptable to the Government and shall restore the utility to full use as soon as practicable.

3.2.3 LIMITS OF GOVERNMENT UTILITY INFORMATION: The Government does not have, nor will it provide, record drawings of Frontier telephone cable plant and Optimum cable. The Contractor shall call 17 CS/SCMP at 325-654-3010 a minimum of five (5) calendar days in advance to have underground communications cable routes marked. In addition, the Contractor shall also notify 1-800-DIG-TESS. In the event the Contractor identifies utilities in the contract work area, which interfere with the newly proposed construction, the Contracting Officer shall be immediately notified, and the Government will take necessary corrective action at no cost to the Contractor. The Contractor shall furnish to the Contracting Officer as-built drawings clearly identifying the exact location of all utilities identified in the work area prior to project final inspection.

4. SAFETY AND HEALTH:

4.1 All Contractor operations shall be conducted and performed in accordance with Department of Labor, OSHA requirements found in 29 CFR 1910 and 29 CFR 1926, Air Force Instruction 91-203, AFOSH standards including but not limited to ANSI, NFPA, ASTM, and CPSC as applicable, and handbooks, and the Corps of Engineers (COE) Safety Manual 385-1-1 all editions in effect on the date of the solicitation. The Contractor shall comply with all mandatory requirements for lockout/tag out, confined space, hazard communication, fall protection, personnel protection equipment, scaffolding, powered construction equipment, and all project related safety and health requirements.

4.2 All companies who conduct business within the state of Texas must, in accordance with Texas Worker's Compensation laws (Texas House Bill 62), have an approved company safety policy and an Accident Prevention Plan. The plan, approved by the Texas Worker's Compensation Commission (TWCC) and meeting all of the requirements of the COE Safety Manual, shall be submitted For Information Only (FIO) in accordance with paragraph 8.8 SUBMITTAL REQUIREMENTS.

4.3 All holes/pits/trenches/manway openings, etc, that are to be left open shall be surrounded with a 48 inch high mesh fence with highly visible orange plastic coating with warning signs posted "Keep Out" and blinking light from dusk to dawn. Guardrails, fences, barricades, and warning lights or other illumination shall be provided in roadwork construction or near vehicular traffic areas. Fence shall be securely anchored with tension wires and posts as required to prevent sagging and located a minimum of 3 feet from the opening so as to prevent an individual, should they fall across the fencing, from falling into the opening. All exposed trenches/Holes shall also be covered, when not being worked in, with three quarter inch plywood or a metal grating that will prevent anyone from entering the trench/hole.

4.4 ASBESTOS and LEAD BASED PAINT: Refer to Section 014000 Environmental Protection

4.5 LOCKOUT/TAGOUT, HAZARDOUS ENERGY CONTROL:

In addition to the requirements in OSHA Std. 1910.147 (General Industry), if a Contractor needs to lock or tag something out, the Contractor will ensure that affected employees are notified before and after the locks and tags are used.

4.6 BASE FIRE REGULATIONS:

The Contractor shall comply with Base Fire Regulations as set forth by GAFB Fire Prevention. The Contractor will be briefed by GAFB Fire personnel at the project kick-off/pre-con meeting. The Contractor shall use no explosives or fire in performing the work. All work shall be in strict compliance with all National Fire Codes.

4.6.1 WELDING, CUTTING, AND BRAZING:

Fire Protection shall complete inspection of all welding, cutting and brazing operations prior to any operation. The Contractor shall provide the appropriate operable fire extinguisher as required by AFOSH 91-5 Welding, Cutting and Brazing. Air Force Form 592 USAF Welding, Cutting and Brazing permit will be issued prior to any operation and shall be kept on site till completion of operation or permit expires. Contact Fire Protection at 325-654-3532 for issuance of permit.

4.6.2 FIRE HYDRANT USE REQUIREMENTS:

To use water from a Fire Hydrant on GAFB, the Contractor shall submit the form: Contractor Request for Use of Goodfellow AFB Fire Hydrants. The form is available upon request, and mandates that the Contractor use a 2½" National Standard fire thread, Class III Back Flow Preventer and keep it in good operational order.

4.6.3 Fire Alarm System: The installation of fire alarm systems must be certified by a licensed professional possessing a current Texas Alarm Certificate of Registration (ACR). The installation of fire sprinkler systems and hood and duct fire systems must be certified by a licensed professional possessing a current Texas Fire Sprinkler Certificate of Registration. A copy of these certificates shall be submitted. Prior to performing any work or disconnecting or shutting off any fire alarm, fire sprinkler system, or hood and duct system, the Civil Engineer Alarms shop at [325-654-1678](tel:325-654-1678) and Fire Protection [325-654-3532/33/34](tel:325-654-3532/33/34) shall be notified by the Contractor. After completing work on any fire protection alarm system, sprinkler, or commercial cooking suppression system, the proper completion documents and/or inspection and test documents, shall be completed and submitted to the Contracting Officer, that comply with NFPA 72, NFPA 13, NFPA 96, or NFPA 24 as applicable.

4.7 CONFINED SPACE ENTRY:

All operations involving entry into confined spaces are performed by the Contractor and shall meet the requirements of OSHA 29 CFR 1910.146, AFOSH Std 91-25 (may be viewed at the website <http://www.publishing.af.mil/shared/media/epubs/AFOSHSTD91-25.pdf>), shall be briefly described during the pre-construction meeting with the Contracting Officer, and specifically comply with the following:

- a.) All entry supervisors, attendees, and confined space entrants shall have been properly trained in the safety hazards, proper use of Personal Protective Equipment (PPE), entry procedures, and self-rescue. Records of this training must be readily available.
- b.) Entry supervisors shall maintain a Master Entry Plan (MEP) consisting of:
 - (1) Descriptions of confined spaces to be entered including location, classification, and acceptable entry conditions.
 - (2) Designation of authorized entry supervisors, entrants, and attendees.
 - (3) Identification of the types of tasks to be performed in the confined space including duration.
 - (4) Procedures for entry and emergency rescue.
 - (5) Identification of Personal Protective Equipment (PPE), communication equipment, rescue equipment, testing equipment, and monitoring equipment; conditions under which they will be used; and verification of condition of equipment.
 - (6) Designation of frequency and type of atmospheric monitoring.
 - (7) Designation of controls required (e.g., lockout/tagout, ventilation, etc.).
 - (8) Procedures for communication during confined space operations.
- c.) All AFOSH Std 91-25, chapter 7 requirements will be met and documented. If both Contractor and Government will be accomplishing confined space entry, all procedures (permits required, operations plan, and procedures) shall be documented by the Entry Supervisor prior to operations. The Government will brief known hazards and the Fire Chief will approve or disapprove rescue.
- d.) All confined spaces shall be tested by a qualified person using a properly calibrated monitor for percent oxygen, lower explosive limit (LEL), and toxicity each time before entry and periodically during operations that have the potential to alter atmospheric conditions.

4.8 STREET CLOSINGS:

NOTE: Under no circumstances shall the Contractor open cut or block off Vance Street. Vance Street is the primary access street for all emergency vehicles and shall remain open at all times. Under no circumstances shall any Contractor vehicle, material storage or equipment be parked on Vance Street. The Contractor shall immediately remove/relocate all items blocking or impeding emergency vehicle access.

4.8.1 When Road closures are required, written notification must be made to the Contracting Officer a minimum of 7 calendar days in advance. One lane of traffic shall be maintained at all times unless otherwise approved in writing by the Contracting Officer. The Contractor shall notify the Security Forces at [325-654-3504](tel:325-654-3504) and Base Fire Protection at [325-654-3532](tel:325-654-3532) three days prior to any closures. Personnel exposed to a traffic environment during hours of darkness, periods of reduced visibility, or as part of construction or maintenance activities, will be provided and use reflective vest/accessories.

4.8.2 The final street repair shall be completed within 14 days after the start of any street demolition for utility crossings or other purposes. Any part of the street returned to service prior to final repair shall be maintained smooth with temporary cold-lay asphalt surface course. All physically exposed portions of the work shall be properly covered or repaired the same business day that the work began.

4.9 NUCLEAR DENSITY PERMIT:

Civilian Contractors or any other agency bringing a radioactive device (e.g., soil or asphalt density meter) on Goodfellow AFB must have prior approval from the Base Radiation Safety Officer (RSO). An application to bring a radioactive device on Goodfellow AFB shall be forwarded to the Base RSO through the Contracting Officer at least 7 days prior to the anticipated use. The application package shall include:

- a.) Copy of the appropriate Nuclear Regulatory Commission License (NRC) or NRC Form 241 authorizing the Contractor to operate or own a radioactive device.
 - b.) Copy of the operator's qualifications and radiation safety training.
 - c.) Radiation dosimetry results for the operator for the prior calendar year, if applicable.
 - d.) Statement of the expected storage and security requirements or other particular needs of the Contractor.
 - e.) Copies of the last leak tests, more as required.
 - f.) Date and time the testing Contractor is expected to be on base.
- Under no circumstances shall an unlicensed radioactive device be used on Goodfellow AFB. Any questions on Contractor's responsibilities regarding this requirement should be directed to the Base RSO, 17 MDOS/SGOAB, 325-654-3126, prior to the Contractor starting work.

5. SITE MAINTENANCE:

5.1 GOVERNMENT STORAGE:

There are no Government furnished covered or secure storage areas. The location on Goodfellow AFB of the Contractor's temporary field office, storage, and other construction buildings required temporarily in the performance of the work, shall require written approval of the Contracting Officer. Plans showing temporary field office, storage, and other construction buildings shall be submitted for Government Approval (GA). Utilities at the storage area may or may not be available for Contractor use. The Government implies no responsibility for lost or stolen materials, equipment, or tools, the security of which lies solely with the Contractor. Contractor shall keep his storage areas clean, neat, and orderly.

5.2 SITE CLEANLINESS:

All Contractor trailers shall maintain a professional appearance. The Contractor shall collect all trash, debris, refuse, garbage, etc., that is generated and place it in appropriate disposal containers with lids on a periodic basis or as directed by the Contracting Officer's Representative. Disposal shall be outside the limits of Government property. Disposal shall be by sanitary landfill or other approved methods and shall conform to all local, state, and federal guidelines, criteria, and regulations. Restoration of the original ground contours is required unless otherwise directed by the Contracting Officer's Representative.

5.2.1 SITE FINAL CLEAN-UP:

The Contractor shall at all times keep the construction site, construction trailer(s)/building(s), and storage area(s) in a clean, neat, workman like condition, free from accumulation of waste, rubbish, weeds, overgrown grass, or construction debris to the satisfaction of the Contracting Officer. All loose or light weight materials shall be secured to prevent blowing or scattering. The burning of trash or construction debris is strictly prohibited on Goodfellow AFB. Prior to final inspection, the Contractor shall remove all construction debris, tools, equipment, and materials not the property of the Government. Upon completion of the work, the Contractor shall leave the work site and storage area(s) in a clean, neat, and workmanlike condition satisfactory to the Contracting Officer. All equipment and materials to be removed from the project site not specifically identified for turn-in to the Government shall become the property of the Contractor upon issuance of the Notice to Proceed (NTP).

5.3 SITE SURROUNDINGS:

At all times, the Contractor shall exercise care to reduce noise and ensure safe construction activities while minimizing disturbances to adjacent police and fire facilities. All adjacent buildings are mission essential facilities manned 24/7 and will remain occupied during duration of this contract. The Contractor shall conduct all work such that means of facility ingress and egress are maintained at all times for all surrounding buildings. All adjacent

buildings are occupied mission essential training facilities that under no circumstances shall be disturbed by this construction project.

5.3.1 The Contractor shall protect adjacent property, buildings, and their contents from construction activities. Work areas shall be maintained in a neat, clean, safe condition and shall, at a minimum, be cleaned at the end of each shift. All streets and roadways in/or adjacent to the site shall always remain free of project generated trash and debris. Parking on turf is not permitted without written approval.

5.3.2 CONTRACTOR STORAGE AND DELIVERIES:

All equipment and materials delivered shall be secured with protection from the weather, high winds, humidity, temperature variation, dirt, and any other contaminants. The project documents will designate Contractor storage and laydown yards. All project storage areas shall be kept free of debris, leaks, stains, or splashes and kept in a neat, clean, and safe condition. Any contamination of the storage area by a hazardous substance shall be immediately remediated by the Contractor, in accordance with the contract above at no additional expense to the Government. Upon completion of the work, the Contractor shall leave the work site and storage area(s) in a clean, neat, and workmanlike condition satisfactory to the Contracting Officer.

5.3.3 MOWING:

All Contractor work areas shall be maintained including yard/grass regularly cut/trimmed by the Contractor. Contractor shall mow vegetation when it reaches a height of 6 inches. Mowing shall be to a height not less than 2 inches. Mowing shall be accomplished with a rotary mower that leaves the clippings evenly distributed on the soil surface. Towed or self-propelled riding mowers shall not be operated within 3 feet of shrubs or trees. Contractor shall mow areas adjacent to shrubs and trees with hand propelled mowers. Mowing shall be accomplished during daytime periods and in a manner that the soil and grass will not be damaged.

5.4 BARRIERS AND SIGNAGE:

5.4.1 HOLES AND TRENCHES:

All holes which are left open shall be surrounded with a 48-inch-high mesh fence with highly visible orange plastic, warning signs, and blinking light from dusk to dawn. When not being worked, all exposed trenches and holes shall be covered with three quarter inch plywood or a metal grating that will prevent anyone from entering the trench/hole.

5.4.3 TRAFFIC SIGNAGE:

The Contractor shall be responsible for providing suitable, approved signs, barricades, roped barriers, etc., to warn occupants of hazardous areas at the job site for the entire duration of the contract. The Contractor shall always ensure safe pedestrian/troop marching access from construction activities. Contractor shall be responsible for installing appropriate signage regarding worker health safety, wage determination laws, and OSHA requirements as required in the Contractor work trailer or on the security fence if a trailer is not provided.

5.4.4 PROJECT SIGNAGE:

The Contractor shall provide project signage and install either surface mounted to the fence or with a freestanding frame. Project signage shall be displayed at all times with Contractor information, Contractor POC information, name of project, and Government POC information. Signage shall be 48"x96" and shall use Federal Standard colors, using white lettering on dark background, or black lettering on white background. The Contractor shall provide signage regarding worker health safety, wage determination laws, and OSHA requirements as required by these Specifications and post in a visible area onto the Contractor work trailer or project fencing if a temporary trailer is not provided.

5.5 SITE CONTROLS:

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property

of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The use of explosives and burning shall not be permitted.

5.6 CONCRETE TRUCKS: Cleaning out of concrete trucks on Goodfellow AFB is prohibited. Only a concrete truck's chute may be rinsed at the construction site. Wastewater and concrete from this rinse shall be collected in a high-density polyethylene (HDPE) plastic-lined box or pit provided by the Contractor at the site. At the end of pouring operations, the Contractor shall excavate all the waste and liner and properly dispose of same. The Contractor shall dispose of all concrete debris to an authorized off base site and shall remove all concrete debris and residue at the end of the project at no additional cost to the Government. The pit shall be completely backfilled, and the site restored to original conditions.

6. TOILET FACILITIES:

There are no toilet facilities available for Contractor use. Contractor shall provide his/her own portable/temporary toilet facilities. Use of B3321 shower/restrooms facilities will not be permitted.

7. EXECUTION:

7.1 INSPECTIONS:

Contractor shall provide the Government a minimum 24 hours written notice prior to the scheduled inspection. Any work that covers or inhibits the ability of a government inspector from completing his QA inspections under standard construction conditions is subject to removal and replacement at the Contractor's expense.

7.1.1 QUALITY ASSURANCE:

In all work performed, it is the Contractor's responsibility to perform proper QC inspections throughout the project to ensure a quality product. The Government inspector is responsible for adequate Quality Assurance (QA) for the work accomplished. It is not the role of the Government to perform the Contractor's QC for the project, especially during inspections. All work regarding meetings and inspections shall be performed by the Contractor in accordance with the attached Project Documents.

7.2 PROGRESS MEETINGS:

The Contractor shall attend and support weekly progress meetings either in person or via teleconference throughout the life of the contract. The Contractor shall prepare and maintain the periodic meeting agenda report which shall include the record of new and old discussion of technical issues, periodic earned value progress showing percent complete actual versus planned, tabular report of late tasks derived from the progress updated IMS, a four week look ahead, and tabular report for Requests for Information (RFIs) and submittals (open and upcoming). The Contractor shall prepare, and submit for review, presentation materials for meetings and an agenda. The Contractor shall prepare minutes for meetings attended, including teleconferences, and "Red Zone Meetings", and distribute minutes to attendees within three (3) working days.

7.3 PRE-FINAL INSPECTION

The Contractor shall conduct a pre-final walk-through inspection and publish the pre-final inspection findings in a pre-final inspection report. The Contractor shall certify that 100% of the Contractor's QC punch list is completed prior to requests for a Government pre-final inspection, with their completed QC punch list attached. The Contractor shall conduct a pre-final walk-through inspection with a Government representative and publish the inspection findings in a Government pre-final inspection report. Contractor shall comply with all applicable provisions listed in the attached Project Documents regarding pre-final inspection requirements. Pre-final inspection report shall include a list of Contractor warranty and manufacturer warranty books/certificates from newly installed equipment and materials. At the pre-final inspection, the Contractor shall present a draft DD Form 1354, Transfer and Acceptance of Real Property to the Base Civil Engineer (BCE) or other appropriate organization for review. DD Form 1354 will be furnished by the Government upon request. The Contractor shall be responsible for completing and submitting to the Government the Project Closeout Checklist during this Pre-Final Inspection.

7.4 RED ZONE MEETING & FINAL INSPECTION:

7.4.1 RED ZONE MEETING:

The term "Red Zone" refers to the last 20% or so of actual construction during which BCE, Contractor, and Installation Stakeholders must make a coordinated effort to complete physical construction, as well as all required documentation, financial actions, permit requirements, system commissioning and training of operators. The

Contractor shall initiate, schedule, organize and lead this meeting. Upon request additional information on the Red Zone meeting will be provided to the Contractor.

7.4.2 FINAL INSPECTION:

At the contract final inspection, there will be a joint Tom Green County, Government, and Contractor inspection to include operational testing of all fire detection, plumbing, communications, electrical, mechanical devices, and equipment to ensure all facility systems are functioning and operable. Under no circumstances will Goodfellow AFB occupy or operate in any building areas under construction without consent from the Contractor or in emergency situations.

The Contractor shall certify that 100% of the pre-final punch list is completed prior to requests for a Government final inspection. The Contractor shall conduct a final inspection and publish the findings in a final inspection report (Punch List) in accordance with the format specified in the attached Project Documents. The inspection shall concentrate on the items identified at the pre-final inspection and recorded in the pre-final report. The final inspection report shall (1) certify that all items of the design have been implemented and that the construction is complete; (2) include a record of as-built drawings and specifications verifying that all development standards have been met; (3) schedule to complete the punch list; (4) One year Contractor warranty and manufacturer warranty books/certificates from newly installed equipment and materials. At the final inspection, the Contractor shall provide a completed DD Form 1354, Transfer and Acceptance of Real Property to the Contracting Officer. Refer to paragraph 8.6 DD FORM 1354 for additional information.

7.5 TESTING:

7.5.1 The costs of all tests, unless specifically indicated as being performed by the Government, shall be at the Contractor's expense. The Contractor shall schedule all tests and notify the Contracting Officer or his/her representative in a timely manner prior to any required testing. All test results shall be submitted to the Contracting Officer on AF Form 3000, Material Approval Submittal. Where test reports are to be submitted to the Contracting Officer within 24 hours after the tests are performed, the results may be faxed to the Contracting Officer at a number provided at the preconstruction conference.

7.5.2 Testing laboratories must be licensed to operate in the State of Texas and must meet the following:

- "Recommended Requirements for Independent Laboratory Qualification", published by American Council of Independent Laboratories
- Basic requirements of latest edition of ASTM E329 "Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials Used in Construction."
- Latest edition of ASTM E 548, "Qualifications for Testing Labs"

8. SUBMITTALS:

8.1 AS-BUILTS:

Existing As-Builts of the original Fire Station, B3321 will be furnished by the Government upon request.

The Contractor shall maintain two sets of project drawings with red-line "as-built" notations and markings. Prior to the final inspection, the Contractor shall transfer these red-lined changes to a CADD format that is fully compatible with Autodesk's AutoCAD version 2018 or greater. The Contractor shall submit one full size hard copy set of as-built maps along with electronic copies in pdf and CADD formats. In addition, the Contractor shall develop and submit GIS data sets on all improved areas. The government will provide the contractor with a copy of Goodfellow's most current data sets. These data sets shall be compatible with ArcGIS v9.3 format and shall have a minimum accuracy of one meter. The coordinate system for both AutoCAD and GIS files shall be in WGS 1984, UTM Zone 14. The Contractor shall submit two copies of electronic files on a CD or DVD under the cover of an AF Form 3000. The CD or DVD label shall contain, at a minimum, the following information: (1) Brand and version of the CADD software used to generate the drawing files; (2) Short description of the contents including a cross reference of the drawing file names on the CD or DVD and the project drawings sheet sequence numbers or sheet titles; (3) Statement marking the CD or DVD as "as-built" drawings; and (4) any directions required to open files.

The Contractor shall submit an interim/draft DD FORM 1354 with all relevant data 30 days prior to the final inspection and the final DD FORM 1354 shall be provided at the project final inspection as prescribed in UFC 1-300-08. Refer to paragraph 8.6 DD FORM 1354 for additional information.

8.2 OPERATION AND MAINTENANCE MANUALS:

The Contractor shall provide system O&M manuals and parts list to the Government, and train maintenance personnel in system operations prior to delivery and Government acceptance, as well as manufacturers' point of contacts (POCs) for troubleshooting, repair and consulting questions. All warranty information shall be provided by the Contractor as described in the attached Project Documents. Required instruction manual(s) shall be provided in three-ring binder(s) with tabs and an index/table of contents. Provide permanent label on front and side with project title, project number, facility number, street address, Contractor/subcontractor name, address, phone number(s), and manual title/contents description. Include all wiring diagrams and parts lists.

8.3 WARRANTIES:

The Contractor shall provide at minimum a one (1) year Construction warranty for all work conducted on this project.

The Contractor shall identify all items being installed that are guaranteed or under warranty for more than a one-year period and provide validated copies of the manufacturer's warranty to the Government. All warranty information shall be filed by the Contractor in the name of Goodfellow AFB. All warranties shall be identified by product with a listing of the name and address of the company and the expiration date of the guarantee or warranty. Any warranties given to the Contractor or subcontractor at any tier from a manufacturer of equipment or other items, which are provided under this contract, shall be transferred to the Government upon final acceptance in accordance with the clause contained in the basic contract, Section I. Contractor shall submit in writing a single listing with all applicable warranties attached, complete Equipment List AF Form 3136 with submission of DD Form 1354. Refer to Attachment "C". Negative responses are likewise required in writing.

8.4 CONTRACTOR QUALITY CONTROL REPORTS:

The Contractor shall establish and submit to the Contracting Officer a written daily quality control report to assure compliance of this project package. Any work found not to comply with the contract shall be promptly removed, replaced, or corrected in an approved manner. Written Daily quality control reports shall be submitted at the end of each work period, to include, but not be limited to the following:

- a.) Number and skill level workers and start and end time of various tasks.
- b.) Materials delivered to job site.
- c.) Work accomplished or in progress.
- d.) Remarks or special instructions on delays and safety.
- e.) Weather conditions, adverse weather days

8.5 SCHEDULES AND PLANNING CHARTS

8.5.1 The Contractor shall be responsible for providing progress schedules for tracking work and payment progress.

8.5.2 CONSTRUCTION PLANNING CHART (CPC)

The Contractor shall prepare and submit a CPC that fully describes the means to perform all work including but not limited to providing all equipment, tools, materials, supplies, transportation, supervision, management, proposed project schedules, work sequence plans, associated configurations for all demolition and new work including Architectural, Mechanical, Electrical, Telecommunications, and Security / Video Surveillance infrastructure in an AF Form 3064 for approval. The CPC shall detail the project schedule and status using Gantt charts, which shall depict percent complete for each task. The Contractor shall supply all labor, equipment, and materials necessary to accomplish the work assigned unless otherwise specified. The Contractor shall perform management and planning functions, including performance measurement and status reporting to effectively secure and monitor prime and sub-contract work.

8.5.3 INTEGRATED MASTER SCHEDULE IMS)

8.5.3.1 The Contractor shall submit the Initial IMS and AF Forms 3064/3065 for approval within (30) thirty calendar days after award or as otherwise directed by the CO for Government review, evaluation, and approval on an AF Form 3000. The Initial IMS shall be prepared and submitted in Primavera P6, or approved equal, submitted in .pdf formats and shall be based on the schedule presented in the Contractor's accepted proposal. The Initial IMS shall be cost loaded according to contract award most current Construction Specification Institute (CSI) Divisions and include major cost/schedule drivers such as, major material submittals and/or long lead-time items, work plans, and project close-out. The Initial IMS shall include an advanced level of detail and include all necessary activities, tasks, and subtasks to reflect all remaining construction activities. The Contractor shall provide the Initial IMS schedule and must provide (10) ten business days for Government review and approval of construction material submittals. The approved IMS shall not be re-baselined by the Contractor without approval by the CO. In the event of a contract

change the Contractor may provide a re-baselined schedule, showing any new activities created by the change. Also, with the new schedule a narrative must be provided, detailing how any tasks in the previous schedule were altered in the new, updated schedule.

8.5.3.2 The Government shall use the IMS to measure the progress of the work based on earned value and aid in evaluating all progress payments. The project schedule shall be cost loaded with relationships to CSI divisions. The Contractor shall progress the schedule monthly unless otherwise directed by the CO. At a minimum, the AF Form 3064/3065 shall be derived from the IMS and be structured by major CSI divisions and assigned appropriate value in relationship to overall work and contract value. The Contractor shall submit the updated progressed IMS (in native format and .pdf), and AF Forms 3064/3065 every month. Provide a narrative report with the Initial and each Periodic Update of the project schedule. The narrative report shall include: a description of activities along the 2 most critical paths where the total float is less than or equal to 20 workdays, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. The narrative report is expected to communicate to the Government, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis. Identify and explain why any activities that, based their calculated late dates, should have either started or finished during the update period but did not. Upon acknowledgement of the NTP and continuing throughout the contract, the Contractor shall record on the daily report, the occurrence of adverse weather and result impact to normally scheduled work. Weather delays are by definition only considered for activities on the critical path of the IMS and for 8-hours, i.e., one workday, at a time and shall not be considered for delays of less than 8-hour increments.

8.6 DD FORM 1354:

The Contractor shall prepare and submit a draft DD Form 1354 prior to the Pre-Final Inspection. If no Pre-Final Inspection will take place, the Contractor shall submit a draft DD Form 1354, make edits as required by the Government, and a Final DD Form 1354 prior to the Final Inspection.

8.7 SUBMITTAL REGISTER

The Contractor shall provide product/material submittals in the form of manufacturer's data, certificates of compliance and samples for all items provided and installed per the attached Submittal Register and these specifications. The Contractor will not be permitted to perform any work or install any materials or equipment on site without approved submittals. The submittals listed on the attached Submittal Register shall be required and shall be submitted in accordance with Division 01 33 00 SUBMITTAL PROCEDURES. The Contractor shall use AF Form 3000 to process submittals. Submit digital copy of submittals to Contracting Officer, paper copies upon request only.

9. CYBERSECURITY:

The Contractor shall complete and submit via AF Form 3000 the spreadsheet included as Appendix "A" of the Division 01, General Requirements specification. The Contractor shall submit one comprehensive spreadsheet listing all products to be connected to the internet (IP address). The spreadsheet (Excel) document will be provided by the Government upon request following contract award.

END OF SECTION 010100

SECTION 010200 - UTILITIES (CONTRACTOR IDENTIFIED)

1. SCOPE: This section covers identification, interruption, and use of utilities.

2. IDENTIFICATION:

The Government does not know the exact location of all utilities in the work area. The Contractor shall take reasonable precautions in determining the exact location of all existing utilities within the contract work area prior to any excavating, trenching, backfilling, or disturbance. Upon request by the Contractor, the Government shall furnish all available information in its possession concerning utilities in the contract work area. However, the accuracy of the information provided by the Government is not guaranteed and is only intended to provide some measure of assistance to the Contractor. The Government does not have, nor will it provide, record drawings of Frontier telephone cable plant and Optimum cable. The Contractor shall call 17 CS/SCMP at ~~325-654-3010~~ a minimum of five (5) calendar days in advance to have underground communications cable routes marked. In addition, the Contractor shall also notify 1-800-DIG-TESS. In the event the Contractor identifies utilities in the contract work area, which interfere with the newly proposed construction, the Contracting Officer shall be immediately notified and the Government will take necessary corrective action at no cost to the Contractor. The Contractor shall furnish to the Contracting Officer as-built drawings clearly identifying the exact location of all utilities identified in the work area prior to project final inspection.

2.1 Contractor must initiate and process for approval Work Clearance Request AF Form 103 through 17 CES/CECC a minimum of fourteen (14) calendar days prior to the start of any construction work. Excavation is not authorized without issuance of a completed and approved AF Form 103. After initial issue, it is the Contractor's responsibility to keep the Work Clearance Request coordinated and up-to-date/current through the remainder of the contract.

2.2 Any removal/relocation/reconnection of any communication device shall be coordinated in advance with 17 CS/SCMP at ~~325-654-3010~~. Any removal/relocation/reconnection of any Cable TV device shall be coordinated in advance with 17 CS. Communications and Cable TV devices to remain shall be protected as required when work proximity dictates.

3. INTERRUPTIONS:

3.1 Planned Utility Outages: The Contractor shall coordinate all requests for utility outages with the Contracting Officer in writing fourteen (14) calendar days prior to date of requested outage. Water, gas, sewer and electrical outages shall be held to a maximum duration of 2 hours unless otherwise approved in writing.

3.2 Unplanned Utility Outages (Accidental Disruption of Utilities): In the event of accidental disruption of any utility, the Contractor shall immediately notify the Contracting officer of the unplanned outage. The Contractor shall immediately take every reasonable step to repair the damage in a manner acceptable to the Government and will restore the utility to full use as soon as practicable. Additionally, if the unplanned interruption affects Military Family Housing (MFH) areas, the Contractor shall provide verbal or written notice to each affected family. If the Contractor so desires, and the Government agrees, the Government will complete necessary repairs to the damaged utility and withhold from payments due to the Contractor the necessary amount to defray all costs associated with the repair of the utility.

3.3 For all drinking water disruptions and new construction, the Contractor shall adhere to 30 TAC 290 Subchapter D paragraph 290.46(g and j). Submit Drinking Water Analysis Report and a "Drinking Water Customer Service Inspection checklist" via an AF Form 3000 for Government Approval. Contact Bioenvironmental Engineering at ~~325-654-3126~~ prior to restoring drinking water service.

4 USE AND AVAILABILITY:

All reasonable quantities of existing utilities will be made available to the Contractor without charge. Proposed temporary connections must be coordinated with the Civil Engineering Utilities Shop at ~~325-654-1480~~ or ~~325-654-3487~~ in advance of any connection. Any temporary connections or lines required shall be installed, metered, maintained, and removed at the Contractor's expense. Any damage associated with the use of these utilities shall be repaired and/or replaced in a manner satisfactory to the Contracting Officer at Contractor's expense. Prior to using any fire hydrant on Goodfellow AFB, the Contractor must complete the Contractor Request for Use of Goodfellow AFB Fire Hydrants (a copy of which is attached at page 01020-3) and submit to the Contracting Officer and notify the Fire Dept. at ~~325-654-3532~~.

Contractor shall take appropriate measures to prevent backflow into the base's potable water supply system. Contractor shall always strive to conserve the electric, natural gas and water utilities at Goodfellow Air Force Base.

END OF SECTION 010200

The following information must be prepared and forwarded, on AF Form 3000, Material Approval Submittal, to the Operational Contracting Division for approval and coordination with Civil Engineering's Fire Dept and Utilities Element prior to use of base fire hydrants.

Contractor Request for Use of Goodfellow AFB Fire Hydrants.

1. The _____ Company requests the use of fire hydrant number _____ for the purpose of filling _____ used in the performance of the contract to _____. Period of hydrant use will be to _____. I understand approval is contingent on:

- a. The company providing a suitable connection with a Class III Back Flow Preventer (reduced pressure principle device) and screw type globe valve to be attached to the hydrant. The connection will be 2 1/2" National Standard fire thread. The backflow device and valve shall be properly supported to prevent damage to fire hydrant threads.
- b. Leaving the connection in place during approval period.
- c. Insuring the hydrant is fully opened and left in that position during approval period, except in periods of freezing weather.
- d. Insuring an approved fire hydrant wrench is used to open/close the hydrant.
- e. Insuring all servicing from the hydrant is done at the top of the vehicle or tank. No bottom servicing will be permitted.
- f. Using no quick opening valves causing excess water hammer in the main.
- g. Discontinuing hydrant use if there is any hydrant malfunction or leakage from underground and reporting same to the fire department, 654-3532.

2. I understand and agree that _____ Company assumes full responsibility for any damage to the hydrant, water mains, adjacent grounds, vegetation, buildings, or streets resulting from filling operations.

(Signature)

(Print Name)

(Date)

(Print Title)

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

- Coordination drawings.
 - Requests for Information (RFIs).
 - Project Web site.
 - Project meetings.

- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor by the General Contractor.

- C. Related Sections:

- Division 1 Section "Submittal Procedures" for submitting Shop Drawings, Product Data, and other miscellaneous submittals.
 - Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

1.3 DEFINITIONS

- A. RFI: Request from Owner, General Contractor, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

- Name, address, and telephone number of entity performing subcontract or supplying products.
 - Number and title of related Specification Section(s) covered by subcontract.
 - Drawing number and detail references, as appropriate, covered by subcontract.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities, and activities of other contractors, to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.

6. Pre-installation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.6 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.

2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

- 1 Project name.
- 2 Project number.
- 3 Date.
- 4 Name of Contractor.
- 5 Name of Architect and General Contractor.
- 6 RFI number, numbered sequentially.
- 7 RFI subject.
- 8 Specification Section number and title and related paragraphs, as appropriate.
- 9 Drawing number and detail references, as appropriate.
- 10 Field dimensions and conditions, as appropriate.
- 11 Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
- 12 Contractor's signature.
- 13 Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: AIA Document G716.

D. Architect's and General Contractor's Action: Architect and General Contractor will review each RFI, determine action required, and respond. Allow seven (7) calendar days for Architect's response for each RFI. RFIs received by Architect or General Contractor after 1:00 p.m. will be considered as received the following working day.

- 1 The following RFIs will be returned without action:
 - A. Requests for approval of submittals.
 - B. Requests for approval of substitutions.
 - C. Requests for coordination information already indicated in the Contract Documents.
 - D. Requests for adjustments in the Contract Time or the Contract Sum.
 - E. Requests for interpretation of Architect's actions on submittals.
 - F. Incomplete RFIs or inaccurately prepared RFIs.

E. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.

F. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal.

G. If the Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and General Contractor in writing within ten (10) days of receipt of the RFI response.

1.7 PROJECT MEETINGS

A. Preconstruction Conference: A preconstruction conference will be scheduled by the General Contractor before starting construction, at a time convenient to Owner. The conference will be held at Project site or another convenient location. The meeting is to review responsibilities and personnel assignments.

- 1 Attendees: All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
- 2 Agenda: Discuss items of significance that could affect progress, including the following:
 - A. Tentative construction schedule.
 - B. Phasing.
 - C. Critical work sequencing and long-lead items.
 - D. Designation of key personnel and their duties.
 - E. Procedures for processing field decisions and Change Orders.
 - F. Procedures for RFIs.
 - G. Procedures for testing and inspecting.
 - H. Procedures for processing Applications for Payment.
 - I. Distribution of the Contract Documents.
 - J. Submittal procedures.
 - K. Preparation of record documents.
 - L. Work restrictions.
 - M. Working hours.
 - N. Owner's occupancy requirements.
 - O. Responsibility for temporary facilities and controls.
 - P. Procedures for moisture and mold control.
 - Q. Procedures for disruptions and shutdowns.
 - R. Construction waste management and recycling.
 - S. Parking availability.
 - T. Office, work, and storage areas.
 - U. Equipment deliveries and priorities.
 - V. First aid.
 - W. Security.
 - X. Progress cleaning.

B. Pre-installation Conferences: Pre-installation conferences at Project site will be scheduled by the General Contractor before each construction activity that requires coordination with other construction.

- 1 Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Owner of scheduled meeting dates.
- 2 Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - A. Contract Documents.
 - B. Options.
 - C. Related RFIs.
 - D. Related Change Orders.
 - E. Purchases.
 - F. Deliveries.
 - G. Submittals.
 - H. Review of mockups.
 - I. Possible conflicts.
 - J. Compatibility problems.
 - K. Time schedules.
 - L. Weather limitations.
 - M. Manufacturer's written instructions.
 - N. Warranty requirements.
 - O. Compatibility of materials.
 - P. Acceptability of substrates.
 - Q. Temporary facilities and controls.
 - R. Space and access limitations.
 - S. Regulations of authorities having jurisdiction.
 - T. Testing and inspecting requirements.
 - U. Installation procedures.
 - V. Coordination with other work.
 - W. Required performance results.
 - X. Protection of adjacent work.
 - Y. Protection of construction and personnel.
- 3 Significant conference discussions, agreements, and disagreements, including required

- corrective measures and actions will be recorded by the General Contractor.
- 4 Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: General Contractor will conduct progress meetings at weekly intervals. Dates of meetings will coordinate with preparation of payment requests.

- 1 Attendees: In addition to representatives of Owner, General Contractor and Architect (Architect attending by conference call), each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
- 2 Agenda: General Contractor will review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
- A. Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
- B. Review present and future needs of each entity present, including the following:
- a. Interface requirements.
 - b. Sequence of operations.
 - c. Status of submittals.
 - d. Deliveries.
 - e. Off-site fabrication.
 - f. Access.
 - g. Site utilization.
 - h. Temporary facilities and controls.
 - i. Progress cleaning.
 - j. Quality and work standards.
 - k. Status of correction of deficient items.
 - l. Field observations.
 - m. Status of RFIs.
 - n. Status of proposal requests.
 - o. Pending changes.
 - p. Status of Change Orders.
 - q. Pending claims and disputes.
 - r. Documentation of information for payment requests.
- C. Reporting: General Contractor will distribute meeting minutes to each party present and to parties who should have been present.
1. Schedule Updating: An updated Construction Schedule will be issued by the General Contractor.

E. Coordination Meeting: General Contractor will conduct Project coordination meetings at intervals required for the construction of the Project. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.

- 1 Attendees: Representatives each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 1. Startup construction schedule.
 2. Contractor's Construction Schedule.
 3. Construction schedule updating reports.
 4. Daily construction reports.
 5. Material location reports.
 6. Site condition reports.
 7. Unusual event reports.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 2. Predecessor Activity: An activity that precedes another activity in the network.
 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 1. Float time belongs to Owner
 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

1.4 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including work stages, area separations, and interim milestones.
4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review submittal requirements and procedures.
7. Review time required for review of submittals and resubmittals.
8. Review requirements for tests and inspections by independent testing and inspecting agencies.
9. Review time required for Project closeout and Owner startup procedures.
10. Review and finalize list of construction activities to be included in schedule.
11. Review procedures for updating schedule.

1.5 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from entities involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
- C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than **20** days, unless specifically allowed by Architect.
 2. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 3. Startup and Testing Time: Include no fewer than **15** days for startup and testing.
 4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 5. Punch List and Final Completion: Include not more than 45 days for completion of punch list items and final completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work by Owner: Include a separate activity for the furniture, AV, and artwork installation
 3. Owner-Furnished Products: Include a separate activity for each product. Delivery dates indicated stipulate the earliest possible delivery date.
 4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use-of-premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.

5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 - n. Commissioning.
 6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Temporary enclosure and space conditioned, Substantial Completion, and final completion.
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- G. Contractor's Construction Schedule Updating: monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule at the beginning of each month.
 1. As the Work progresses, indicate final completion percentage for each activity.
- H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- 1.7 REPORTS
- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Testing and inspection.

8. Accidents.
9. Meetings and significant decisions.
10. Unusual events.
11. Stoppages, delays, shortages, and losses.
12. Meter readings and similar recordings.
13. Emergency procedures.
14. Orders and requests of authorities having jurisdiction.
15. Change Orders received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

- 1.8 Submit Daily reports at each weeks progress meeting along with photographs showing the progress of the work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL REQUIREMENTS:

- A. Submittal Classification: Submittals are classified as follows and delineated as such on Submittal Register under the "Classification" column:
- B. "Action Submittals": Government approval is typically required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the contract clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings".
 - 1. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
- C. "Information Submittals":
 - 1. All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract clause referred to above.
 - 2. General Requirements:
 - a. Action and Information submittal data shall be transmitted under separate AF Forms 3000 and assigned different Submission Numbers.
 - b. The Contractor shall designate on each AF Form 3000, in the "Submission Number" block, either Action or Information to show the transmittal type. This procedure allows ready identification of Action or Information submittals.
 - c. Submittals transmitted with AF Form 3000 shall be identified by marking it with the same Submission Number appearing in the "Line Number" column on the Submittal Register.
 - 3. Specific Requirements for Information Submittals:
 - a. A single fully coordinated Informational submittal shall be made for each technical section listed/required on the Submittal Register. Each submittal listed on the Submittal Register shall be submitted as a separate item on the AF Form 3000 in the order they appear on the Submittal Register. Technical data provided with the AF Form 3000 shall conform to the requirements in each Technical Section. Submittals involving colors and interior design shall all be transmitted concurrently.
 - b. Items such as mill certificates or other test data that are usually unavailable until the equipment/material is actually manufactured/fabricated must still be identified on the initial AF

Form 3000. An explanation stating this data shall be submitted later by Submittal Number (fill in Submission Number) after materials are manufactured / fabricated (or other explanations as appropriate) shall be included with this identification. A separate submittal for long lead-time equipment or material may be made if sufficient data is furnished to show contract compliance. (An explanation shall be provided on a separate sheet, if necessary, explaining why a partial submittal is being made. Explanation shall include the estimated delivery date of the equipment/material and the Submission Number of the submittal that shall contain data required by the particular specification section for the remaining equipment/materials.) Explanations for separate or split submittals may be performed via email with the Contracting Officer or approving authority. Samples of materials must be submitted along with technical data, not under separate transmittals.

4. Information Submittal Review:
 - a. The Contractor has full responsibility for reviewing and certifying that all submittal data and all equipment and/or materials fully comply with the contract. Information submittals are for the Government's information and real property record purposes; they will not be approved/disapproved nor returned to the Contractor.
 - b. The Government may perform quality assurance reviews and re-reviews of Information submittals at any time during the contract. If the Government determines submittal data is incomplete or not in compliance with contract, comments will be provided. Comments will state, "Disagree with Contractor's Certified Compliance" and list items not in compliance or not provided as required by the contract. The Contractor shall respond to all comments by return FIO resubmittal on a new AF Form 3000.

D. Specific Requirements for Action Submittals:

1. The Contractor is responsible for controlling and ensuring all data submitted is complete and in full compliance with contract requirements.
2. A separate submittal shall be made for each technical section with Action submittals. Information submittal data shall not be mixed with Action submittal data.
3. The Government will provide written comments and/or approval/disapproval action as appropriate. One (1) copy of the submittal, along with any comments, will be provided to the Contractor. The Contractor shall provide a resubmittal with all data necessary to show compliance with Government comments on all disapproved submittals.

1.4 Variations/Deviations/Departures from the Contract Drawings or Specifications:

- A. Contractor proposed variations, deviations, or departures from the contract requirements shall be noted/marked in red on the face/cover of each copy of the submittal data and shall be provided with a letter attachment to the AF Form 3000 summarizing the proposed variation, deviation, or departure. For Information submittal deviations an asterisk "*" shall be placed in the block under "Submission Number" next to the "Line number." These submittals will then be automatically redesignated Action Submittals. Variations, deviations, or departures will be processed and approved the same as Action submittals. Variations, deviations, or departures shall contain sufficient information to permit complete evaluation. Additional sheets may be used to fully explain why a variation, deviation, or departure is requested. The Government reserves the right to disapprove or rescind inadvertent approval of submittals containing unnoted/unmarked variations, deviations, or departures.
- B. Any submittal annotated by a supplier/vendor with "Field Verify," "Select Color," and the like must be accompanied by the Contractor's written response to the supplier's query.

1.5 Government approval of submittals indicates only that the general method of construction, materials, detailing, and other information appear satisfactory. Approval does not relieve the Contractor of the responsibility for any error which may exist. The Contractor remains responsible for the dimensions and design of adequate connections, details, material compatibility, and satisfactory construction of all work necessary to fulfill the intent of this project.

1.6 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic copies of digital data files of the Contract Drawings can be provided by Architect for Contractor's use in preparing submittals.
 1. Architect will furnish Contractor digital data drawing files as requested of the Contract Drawings for use in preparing Shop Drawings.
 - a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow 10 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Resubmittal Review: Allow 10 business days for review of each resubmittal.
 - 3. Submit one electronic copy to Architect.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
- E. Submittal Format:
 - 1. File name shall use project identifier (Fire Station Add/Alter) followed by Line Item number. Resubmittals shall include an alphabetic suffix after a decimal point
 - a. Example: "Fire Station Add/Alter Submittal 0001A"
 - 2. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 - 3. Transmittal Form type shall be AF Form 3000. Refer to Division 01 00 00 GENERAL REQUIREMENTS for form template.
- F. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
- G. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- H. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements:
 - 1. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:

- a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 22 by 30 inches.
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit 1 full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect

will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit 1 set of Samples to the Architect and keep one set at the job site. Architect will keep the one sample set and send back electronic approval and/or comments.
 - 1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- F. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- G. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- H. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- I. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- J. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- K. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- L. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- O. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- P. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- Q. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- R. Schedule of Tests and Inspections: Comply with requirements specified in Section 014010 "Quality Requirements."

- S. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- T. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- U. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- V. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action. Action, as follows:
 - 1. No Exceptions.
 - 2. Furnish As Corrected.
 - 3. Revise and Resubmit.
 - 4. Rejected.
 - 5. No Received.
 - 6. No Required for Review.
- C. Informational Submittals: Architect will review each submittal and will not return it or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 01400 - ENVIRONMENTAL PROTECTION

1. APPLICABLE ENVIRONMENTAL REGULATIONS, LAWS, AND PUBLICATIONS:

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. All publications shall be the latest version / edition / revision of the documents listed below, in effect on the date of this solicitation, except where a date is given.

1.1. Code of Federal Regulations (CFR):

29 CFR, Part 1910	Hazardous Waste Operation and Emergency Response
40 CFR 61, Subpart M	National Emissions Standard for Hazardous Air Pollutants
40 CFR, Part 82	Protection of Stratospheric Ozone
40 CFR, Part 117	Determination of Reportable Quantities for Hazardous Substances
40 CFR, Part 122	National Pollutant Discharge Elimination System (NPDES) Regulations
40 CFR, Parts 260 - 282	Solid Waste Regulations
40 CFR, Part 302	Designation, Reportable Quantities and Notification
49 CFR, Parts 171-176	Hazardous Materials Regulations, Department of Transportation, (DOT) Rules

1.2. Environmental Protection Agency Publication (EPA):

EPA Publication No. SW-846	Test Methods for Evaluating Solid Waste
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1.3. Environmental Laws:

- Archaeological and Historic Preservation Act (AHPA)
- Archaeological Resources Protection Act (ARPA)
- Clean Air Act (CAA) and all amendments
- Clean Water Act (CWA) as amended
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Endangered Species Act (ESA)
- Emergency Planning and Community Right-To-Know Act (EPCRA)
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended
- Federal Water Pollution Control Act (FWPCA)
- National Oil and Hazardous Substances Contingency Plan (NCP)
- Occupational Health and Safety Act (OSHA)
- Oil Pollution Act (OPA)
- Pollution Prevention Act (PPA)

Resources Conservation and Recovery Act (RCRA)

Safe Drinking Water Act (SDWA), as amended

1.4. State Regulations (Texas Administrative Code):

25 TAC§295	Occupational Health
30 TAC§205	General Permit to Discharge Waste 30
TAC§290	Public Drinking Water
30 TAC§335	Industrial Solid Waste and Municipal Hazardous Waste

1.5. Air Force Instruction (AFI): 32-7001 Environmental Management

1.6. Air Force Manual (AFMAN): 32-7002 Environmental Compliance and Pollution Prevention

1.7. Energy Independence and Security Act (EISA) Section 438

2. ENVIRONMENTAL ISSUES

2.1. Activities which are implemented, in whole or in part with approved funding, must comply with applicable legislation and regulations established to protect the human or physical environment. The Contractor will remain in compliance with Federal statutes during the performance of the contract, including but not limited to the Clean Air Act (CAA), Clean Water Act (CWA), Endangered Species Act (ESA), Resource Conservation and Recovery Act (RCRA), and other applicable laws, regulations, and requirements.

2.2. In order to comply with all Environmental Laws and Regulations as set forth by Federal, State, Department of Defense, Air Force and any other mandated requirements for Federal installations, Goodfellow AFB (GAFB) must comply with and are required to identify, manage and track all chemicals (hazardous materials), air emissions, stormwater, and construction and debris (C&D) that are transported, managed, used, and disposed of from any part of this installation. This requirement is for all installation organizations, workplaces, work centers, shops, and for all Contractors doing any work on the installation. Contractors shall investigate, comprehend, and comply with all environmental rules and regulations applicable to their chosen method of accomplishment of the work under this contract.

2.3. The Contractor will be responsible for and will indemnify and hold the Government harmless for any, and all spills, releases, emissions, and discharges of any toxic or hazardous substance, any pollutant, or any waste, whether sudden or gradual, caused by or arising under the performance of this contract or any substance, material, equipment, or facility utilized therefore for the purposes of any environmental statute or regulation. The Contractor will be considered the "operator" for any facility utilized in the performance of the contract and will indemnify and hold the Government harmless for the failure to adhere to any applicable law or regulation established to protect the human or physical environment. The Contractor will be responsible in the same manner as above regardless of whether activities leading to or causing a spill, release, emission, or discharge is performed by the contractor, its agent or designee, an offender, visitor, or any third party.

3. PROTECTION OF RESOURCES

3.1. Construction activities are NOT exempt from air emission, stormwater, hazardous waste, and other environmental compliance rules and regulations. Contractor shall investigate, comprehend, and comply with all environmental rules and regulations applicable to his/her chosen method of accomplishment of the work under this contract.

3.2. Protection of Land Resources: The Contractor shall confine his/her construction activities to areas defined by the plans and specifications and/or as approved in his/her Storage Area submittal (refer to paragraph 7). Except in areas to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy trees or shrubs without written permission from the Natural Resource Officer/Manager and Contracting Officer. Do not fasten or attach ropes, cables, or guys to existing or nearby trees for anchorage unless authorized by the Natural Resource Officer/Manager and the Contracting Officer. Where such use of ropes, cables, or guys is authorized, the Contractor shall be responsible for any resultant damage.

3.3. Protection of the Stratospheric Ozone: The Contractor shall comply with 40 CFR Part 82. To the maximum extent practicable, the Contractor shall utilize safe alternatives and products made with or containing safe alternatives to Class I or II Ozone Depleting Substances (ODS), identified under 42 U.S.C. 7671K. Class I Ozone Depleting Substance is defined in section 602 (a) of the Clean Air Act (CAA).

Per manufacturer's recommendations, Contractor's shall utilize acceptable refrigerant substitutes such as:
HCFC – 134a HFC – 410a

3.4. Protection of Historical and Archaeological Resources: All known Historical, Archaeological, and Cultural Resources, if any, within the Contractors work area will be designated on the contract drawings.

3.4.1. Recording and Preserving Historical and Archaeological Finds: All items having any apparent historical or archaeological interest outside of designated areas which are discovered in the course of any construction activities shall be carefully preserved. The Contractor shall protect the find in-place by leaving the archaeological find undisturbed and by using flags to mark a fifty-foot radius area around the find. The find shall be immediately reported to the Contracting Officer and the Cultural Resources Manager so that the proper authorities may be notified. All work shall be stopped at once in the immediate area of the discovery until directed by the Contracting Officer to resume work. Any work required to preserve or protect these finds shall be accomplished before work resumes.

3.5. Protection of Water Resources: The Contractor shall not pollute streams, lakes, or reservoirs with fuels, oils, bitumens, calcium chloride, acids, construction wastes, siltation from stormwater runoff, or other harmful materials identified in 40 CFR Parts 117 and 302. It is the responsibility of the Contractor to investigate, comprehend, and comply with all applicable Federal, State, County, and Municipal regulations and ordinances concerning pollution of rivers and streams. All work under this contract shall be performed in such a manner that objectionable or nuisance conditions will not be created in lakes, reservoirs, or streams through or adjacent to the project areas. At least 30 days prior to the start of construction, the Contractor shall apply for coverage under the storm water construction general permit TX 150000 (if necessary by regulation), by filing a Notice of Intent (NOI) via the Texas Commission on Environmental Quality (TCEQ) Form 20022 or applicable online database, for stormwater discharges associated with his/her construction activities for all soil disturbance of more than one acre. A pre-requisite of filing the NOI is to prepare a Storm Water Pollution Prevention Plan (SWPPP) meeting all regulatory requirements and show the Contractor's proposed methodology for controlling erosion, sedimentation, and pollution at the site. Copies of this plan shall be submitted for Government Approval and copies of the NOI shall be submitted to the Contracting Officer (forward to Environmental Office). All non-storm water discharges shall be in accordance with the governing State and Federal regulations. Any project which adds 5,000 SF or more of new horizontal impervious surface must be Energy Independence and Security Act (EISA) Section 438 compliant.

3.5.1. For all soil disturbance of more than one acre, the Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) meeting all requirements specified in the construction general permit and will include the Contractor's Best Management Practices for erosion and sedimentation control at the site. Copies of this plan shall be submitted for Government Approval via AF Form 3000.

3.5.2. Regardless of the amount of soil disturbed, all non-storm water discharges shall conform with the base's Storm Water Management Program regulated by TPDES General Permit TXR040000 for Small Municipal Separate Storm Sewer Systems (MS4).

3.5.3. If a Notice of Intent (NOI) is required for permit coverage, the Contractor shall submit the NOI to the State and provide copies to the Government via Form 3000. The Contractor shall make the required MS4 notifications to the City of San Angelo and the base. Copies of all notifications will be provided to the Contracting Officer via Form 3000. The Contractor shall be responsible for fees associated with obtaining coverage under permit TXR150000.

3.5.4. The Contractor shall also file a Notice of Termination (NOT) on TCEQ Form 20023 or applicable electronic database, promptly after site stabilization is achieved, in accordance with the construction general permit. These forms may be found at the TCEQ website (<https://www.tceq.texas.gov>). The prime Contractor's principal shall sign to certify the NOI/NOC/NOT or Construction Site Notice. A copy of the NOT shall be provided to the Contracting Officer (forward to Environmental Office).

3.5.5. Post-Construction Cleanup or Obliteration: The Contractor shall obliterate all evidence of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess materials, or any other vestiges of construction. It is anticipated that excavation, filling, and plowing of roadways shall be required to restore the area to near natural conditions, which will permit the growth of vegetation thereon. The disturbed areas shall be graded and filled as required, and topsoil shall be spread to a depth of approximately four inches over the entire area and the entire area seeded with thirty pounds (pure live seed) of common Bermuda per 1000 square feet, and then watered as required until a lush, hardy growth is established in compliance with TXR 150000 Construction General Permit. Restoration to original contours is required unless otherwise directed by the Contracting Officer.

3.6. Drinking Water: No water connection from any public drinking water supply system shall be allowed to any residence or establishment where an actual or potential contamination hazard exists unless the public water facilities are protected from contamination. No direct connection or cross-connections between the public drinking water supply and a potential source of contamination is permitted. Potential sources of contamination shall be isolated from the public water system by an air- gap or an appropriate backflow prevention device.

3.6.1. Contractor shall comply with and provide documentation required by 30 TAC 290.46 (j), pertaining to customer service inspections.

3.6.2. General: The Contractor shall ensure a customer service inspection (CSI) certificate is completed and approved by the CO prior to providing continuous water service to all new construction, to existing service where contaminant hazards are suspected, or in conjunction with major renovation or expansion of the drinking water distribution system.

3.6.3. Form: The Contractor shall use the most current TCEQ approved CSI certificate form (TCEQ Form 20699) A copy of the completed CSI form shall be provided to the Contracting Officer (forward to Environmental Office).

3.6.4. License: The inspection and certificate may only be completed by a Plumbing Inspector, a Water Supply Protection Specialists licensed by the Texas State Board of Plumbing Examiners, or a Customer Service Inspector who has completed a TCEQ-approved course, passed an examination administered by the executive director, and holds a current professional certification or endorsement as a customer service inspector.

3.6.5. No pipe or pipe fitting which contains more than 0.25% lead may be used for the installation or repair of plumbing at any connection which provides water for human use.

3.6.6. No solder or flux which contains more than 0.2% lead can be used for the installation or repair of plumbing at any connection which provides water for human use.

3.6.7. All fire hydrants on base that are to be used by the Contractor must be used in conjunction with an approved Class III Back Flow Preventer (reduced-pressure principle backflow assembly device) and screw type globe valve attached to the hydrant. At the Contractors expense the backflow prevention device must be properly installed, tested and maintained. Copies of the testing and maintenance records, if applicable, shall be provided to the Contracting Officer, and GAFB Environmental Element.

3.7. Protection of Fish and Wildlife: The Contractor shall follow all Federal, State, County, and Municipal laws regarding the protection of fish and wildlife. The Contractor shall always perform all work and take such steps required to prevent any interference of disturbance to fish and wildlife. The Contractor shall not alter water flows or otherwise disturb native habitat adjacent to the project area, which, through Contracting Officer and GAFB Natural Resources Officer/Manager, that are critical to fish or wildlife. Construction of check dams in live streams will not be permitted. Fouling or polluting of water will not be permitted. Harassment, harvesting, or taking of any wildlife is not permitted on Federal property, nor is the taking of any resource such as antler sheds, skulls, plant life, or rocks/gems.

3.8. Protection of Air Quality: The Contractor shall investigate, comprehend, and comply with all applicable Federal, State, County and Municipal laws concerning air pollution, particularly the CAA (and all subsequent amendments). All work under this contract shall be performed in such a manner that objectionable or nuisance conditions will not be created in the air, nor will objectionable particulates be released to the air. Material usage of welding rods, welding gases, paints, thinners, solvents, fuels, and asphalt will require reporting to the Contracting Officer (Forward to Environmental Office) monthly throughout the project (VIA form Appendix A and AF Form 3000). No open burning shall be permitted on base.

3.8.1. Dust Control: The Contractor shall maintain all excavations, embankments, stockpiles, haul roads, permanent access roads, plant sites, waste areas, borrow areas, and all other work areas within or without the project boundaries free from dust in accordance with all applicable local, state, and Federal regulations for the control of dust and particulate emissions. Temporary methods of stabilization consisting of sprinkling with water are required to control dust. Sprinkling with water shall be repeated at such intervals as to keep all parts of the disturbed area damp at all times. Gravel paving shall be provided for entrance and exit drives, parking areas, and unpaved roads carrying more than 25 vehicles per day on the construction site.

4. HAZARDOUS MATERIALS:

4.1. Contractors using any type of chemicals (hazardous materials) on Goodfellow AFB must comply with the review and approval process and shall provide the Contracting Officer with a list of proposed materials that it plans to use on the installation during the performance of the contract.

4.2. The Contractor shall provide to the Contracting Officer an AF Form 3000, a Material and Approval Submittal, listing all materials that will be utilized during the contract period. If any of those materials are classified as hazardous and are covered under the Emergency Planning and Community Right-to-Know Act (EPCRA) (42 U.S.C. 11001-11050) or other applicable host Nation, Federal, State, or Local tracking or reporting requirements and also covered under the Occupational Safety and Health Administration (OSHA) Hazard Communication (HAZCOM) Standard (29 CFR 1910.1200) then those materials must be included in the material list submittal.

4.2.1. The Installation HAZMAT Management Program (IHMP) office will determine if any of the proposed materials to be used are hazardous materials (HAZMATs) and will require approval authorizations prior to bringing on or using any of those materials on the installation.

4.3. The Contractor will submit a current Safety Data Sheet (SDS) for each hazardous material to be used under this contract. The Contractor must maintain an on-site file of all SDS during the performance of this contract.

4.4. The Contractor must obtain written authorization from the Contracting Officer and IHMP office prior to bringing or using any hazardous chemicals on the installation. The Contractor shall submit a hazardous chemicals usage report of all hazardous chemicals for Government Approval (via AF Form 3000) to the Contracting Officer on a monthly, quarterly basis, or at the end of the contract, as determined by the Contracting Officer and the IHMP.

4.4.1. The main Contractor is responsible for the hazardous chemical submittals for approval to the Contracting Officer and then to the IHMP office.

4.5. A copy of the DOD INSTALLATIONS OR FACILITIES STANDARD OPERATING PROCEDURE (SOP) - Contractor Tracking Requirement document will be provided to the Contractor at the pre-performance meeting describing the requirement for all Contractors to submit a Contractor Hazardous Materials Usage Tracking Form (to be completed by the Contractor) and copies of the Safety Data Sheets (SDS's) for all chemicals that will be used under any contract.

4.6. If additional hazardous materials are required during the course of the contract, the Contractor shall complete an authorization worksheet and provide an SDS for each additional hazardous material via AF Form 3000 for Government approval prior to bringing or using any additional hazardous materials onto the installation. The Contractor shall submit the new authorization worksheet no later than 15 days prior to delivery of the hazardous materials onto the installation.

4.7. Safety Data Sheets (SDS) are required as specified in the latest version of Federal Standard No. 313 (including revisions adopted during the term of the contract) for any material designated by a Government representative as potentially hazardous and requiring safety controls. SDSs must be submitted by the Contractor upon contract award. Failure to provide SDSs or certificate when requested could result in the Contractor being considered non-responsive and result in termination of the contract.

4.7.1. While there is no single definition that encompasses every type of hazardous chemical, these items generally have a Safety Data Sheet (SDS) prepared by the manufacturer. It is important to note that not every material with an SDS is automatically considered a hazardous material. When there is a question regarding whether or not a material is hazardous, additional guidance should be sought from the CO/COR where they can then forward questions about those materials to the installations Environmental, Safety and Occupational Health (ESOH) team thru the Environmental Office.

4.7.2. Globally Harmonized System (GHS) of Classification and Labeling of Chemicals, per 29 CFR 1910.1200(g) requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) for each hazardous chemical to downstream users to communicate information on these hazards. It also mandates that all workplaces shall not have any SDSs older than five (5) years old and meet the new GHS requirements.

4.8. The Contractor shall not use products that are, or contain any Toxic 17 chemicals, Extremely Hazardous Substances (EHS), Ozone Depleting Substances (ODS), CFC's, or Persistent Bio- accumulative and Toxic (PBT) chemicals. Any Hazardous Material (HM) containing any of these banned substances will not be allowed on the installation.

4.9. If the hazardous material request is for a Class I ODS, CE will ensure there is an applicable and current Air Force Senior Acquisition Official (SAO) approval for contract Class I ODS requirements before approving the hazardous material authorization and make this information available to the Contractor.

4.10. For each Contractor-identified chemical that the IHMP determines does not meet the definition of a hazardous material, then the IHMP requirements do not apply. The IHMP will notify the Contracting Officer that the Contractor has authorization to bring and use that material on the installation without reporting usage unless required under the Green Procurement Program or specifications require data submittals.

5. DISPOSAL OF NON-HAZARDOUS AND SPECIAL WASTES:

5.1. Non-Hazardous Wastes: Non-hazardous solid waste is regulated under 42 U.S. Code Chapter 82 – Solid Waste Disposal - Resource Conservation and Recovery Act (RCRA) Subtitle D, 40 CFR Part 239-259 and under State of Texas 30 TAC §330 - Municipal Solid Waste Rules. Regulations established under Subtitle D ban open dumping of waste and set

minimum federal criteria for the operation of municipal waste and industrial waste landfills. The Contractor shall transport and dispose of all non-hazardous wastes to and in a State of Texas permitted facility or other disposal facility permitted by the state in which the disposal facility is located.

5.2. Special Wastes: Special Wastes are any wastes that are non-hazardous, yet have to be stored, transported, and/or disposed of in a special manner; for example, asbestos containing wastes or petroleum contaminated soil. The Contractor shall store, transport and dispose of all Special Wastes in accordance with all Federal, State, and Local laws, rules and regulations as applicable. The disposal facility must also be approved by the Installations Environmental Office prior to transportation. The Contractor shall make all necessary arrangements with the disposal facility for disposal of Special Wastes.

5.3. The Contractor shall submit all transportation and disposal documentation to the Contracting Officer (forward to the Environmental Office), including but not limited to, waste profiles, bills of lading, manifests, etc. at no additional cost to the Government.

6. HAZARDOUS WASTE:

6.1. The Contractor shall accumulate, transport, and dispose of all hazardous waste in accordance with Federal hazardous waste regulations 40 CFR 260-279 and the Texas hazardous waste regulations described in 30 TAC Chapter 335, and Federal transportation regulations 49 CFR 171-176. The Contractor shall prepare and maintain all records, shipping documents, training certificates, plans, and other documents required by regulation. The Contractor shall submit copies of records, shipping documents, training certificates, plans, manifests, land disposal restrictions and other documents pertaining to this contract and required by 30 TAC, Chapter 335 to the Contracting Officer (forward to Environmental Office). All manifests and land disposal restrictions must be signed by the Installations Environmental Office.

6.2. The Contractor shall remove all hazardous waste pertaining to this contract from Goodfellow AFB on a daily basis unless the accumulation and storage is specifically approved in writing by the Contracting Officer and the Installations Environmental Office. Such approval must be given prior to the generation of any hazardous waste. Approval for accumulation or storage of hazardous wastes in excess of 55 gallons or greater than 1 quart of acutely hazardous waste, for greater than three (3) calendar days will require a minimum lead time of forty-five (45) calendar days from the date of the receipt of the request. The Contractor shall transport hazardous wastes from Goodfellow AFB to a Treatment, Storage, or Disposal Facility (TSDF) permitted by the State of Texas, the EPA, and approved by the Base Environmental Coordinator. Under no circumstances shall disposal or treatment of hazardous wastes be allowed on Goodfellow AFB by the Contractor.

6.3. Reasonable and appropriate measures shall be taken by the Contractor to prevent chemicals, fuels, oils, greases, bituminous materials, waste washings, herbicides and insecticides, and construction materials or debris from polluting the construction site and surrounding area.

6.3.1. The Contractor will be responsible for any, and all spills, releases, emissions, and discharges of any toxic or hazardous substance, any pollutant, or any waste, whether sudden or gradual, caused by or arising under the performance of the contract or any substance, material, equipment, or facility utilized therefore for the purposes of any environmental statute or regulation to protect the human or physical environment.

6.3.2. The Contractor will be responsible in the same manner as above, regardless of whether activities leading to or causing a spill, release, emission or discharge is performed by the contractor, its agent or designee, an offender, visitor, or any third party. If the contractor spills or releases any substance into the environment, the Contractor will immediately report the incident to the Contracting Officer, the Installation Environmental Office and the Installation Fire Department.

6.3.3. The liability for the spill or release of such substances rests solely with the contractor and its agent and at no time will the contractor dispose of hazardous, toxic or caustic substances by unsafe methods. Unsafe methods include spreading or pouring it onto the ground, dumping in a lake, river or stream, and flushing into sewers.

6.3.4. Any materials to be disposed including wastes, effluents, trash, garbage, oil, grease, chemicals, and similar hazardous substances shall be transported to a suitable disposal site by the Contractor subject to the approval of the Contracting Officer and the Environmental Office.

6.3.5. Aerosol Cans: Aerosol cans, after use, must be punctured and drained of product and propellant via approved equipment manufactured for that purpose. The empty cans may then be recycled as scrap metal. Disposal of the internal aerosol can contents shall be accomplished according to its waste classification.

6.3.6. Other Containers: Refer to 30 TAC§335.41(f) for criteria regarding management and disposal of other containers.

6.3.7. The Contractor shall submit all waste transportation and disposal documentation to the Contracting Officer (forward to the Environmental Office), including but not limited to, waste profiles, bills of lading, manifests, etc. at no additional cost to the Government prior to the Final Inspection.

6.3.8. The Government will, as is deemed necessary, inspect the Contractor's operations and records for compliance with Air Force, State and Federal regulations. The Contractor shall cooperate fully with the TCEQ, US EPA and/or Government representatives during these inspections, if any. The Contractor shall be fully and completely responsible for payment of all fines and/or penalties imposed by the TCEQ or US EPA for violation of regulations governing Environmental Management during performance of this contract.

6.3.9. NOTICE: No hazardous materials, lubricants, oils, liquids, general refuse or related materials shall be deposited in the refuse containers on base. The contractor will adhere to all other Federal, State, and Local guidelines regarding environmental practices.

6.3.10. ONSITE DUMPING/CLEANING: Dumping/cleaning out of concrete trucks on Goodfellow AFB is prohibited. Concrete truck chutes only may be rinsed at the construction site. Wastewater and concrete from this rinse shall be collected in a high-density polyethylene plastic-lined box or pit provided by the Contractor at an approved location at the jobsite. At the end of pouring operations, the Contractor shall excavate all the waste and liner and properly dispose of the same. The pit shall be completely backfilled, and the site restored to original conditions.

7. MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

7.1. During the life of this contract the Contractor shall maintain all facilities constructed for pollution control under this contract for as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created. During the construction period, the Contractor shall conduct frequent training courses for his/her maintenance personnel. The curricula shall include methods of detection of pollution, familiarity with pollution standards, and installation and care of vegetation covers, plants, and other facilities to prevent and correct environmental pollution.

8. PESTICIDES (INSECTICIDES, FUNGICIDES, HERBICIDES, ETC.)

8.1. The application of all pesticides shall be accomplished by licensed pest control applicators or under the direct supervision of a State of Texas licensed pesticide applicator. Delivery and storage of pesticides shall be monitored by licensed personnel to insure the adequacy of containers and the safe storage of toxic materials. Disposal of containers and chemicals will be monitored to prevent pollution of natural drainage systems or the unintentional release of pesticide particulates into the air. The Contractor shall comply with FIFRA and submit copies of certifications to the Contracting Officer (via AF Form 3000) for approval prior to application of pesticides. Additionally, the CE Entomology Section at GAFB shall be notified at (325)-654-3496 at least five calendar days in advance by the Contractor of proposed application of any pesticides and copies of all application records shall be submitted to the CE Entomology Section. The Contractor shall use the GAFB pesticide Application Form, available at CE Operations Flight.

9. SPILLS

9.1. Goodfellow AFB maintains, follows, and enforces the following spill plans for regulated substances.
a) Spill Prevention Control and Counter Measures Plan

9.2. These plans are maintained by the Installation Management Flight of Civil Engineering at 460 E. Kearney Blvd, Goodfellow AFB. The Contractor shall take preventive measures (secondary containment for fuel storage, avoid overfilling of trucks, etc.) to avoid spills. If a spill does occur, the Contractor shall immediately notify the Goodfellow AFB Fire Department at phone number 325-654-3532 or 325-654-7000. The Installation Fire Department is the first responder who will take charge to secure/neutralize the event, if required and will coordinate cleanup/remedial actions. Notification shall be made even if the spill is within the cleanup capabilities of the Contractor.

9.3. If the Contractor spills or releases any substance into the environment, the contractor shall immediately report the incident to the Installation Environmental Office at 325-654-5946. The Contractor shall be liable for containment and environmental clean-up of the spill or release.

9.4. The Contractor may be held liable for all expenses incurred by the Government during the spill response and any cleanup operations including, but not limited to a hazardous materials/waste cleanup Contractor, supplies and equipment rental, waste transportation, laboratory analysis, and disposal costs.

10. DEMOLITION

10.1. Demolition Notification: When a project involves demolition, a written notification on the form specified by the Texas Department of State Health Services (DSHS), shall be submitted to the DSHS at least twenty (20) calendar days prior to Contractor's proposed demolition start date. The notification shall be signed by the Base Environmental Coordinator. The Contractor shall be responsible for completing the notification and timely mailing to the DSHS. Contractor shall submit a copy of the signed notification to the Contracting Officer annotated with the date of mailing to the DSHS. The Contractor shall be responsible for timely payment of all fees associated with the work and permit.

11. ASBESTOS:

11.1 Asbestos Containing Building Materials: Under no circumstances, under the provisions of this contract, shall the Contractor be allowed to provide asbestos containing building materials, or products containing encapsulated asbestos mineral fibers as defined in the 40 CFR 61, National Emission Standards for Hazardous Air Pollutants of 1990, to Goodfellow AFB.

11.2 Asbestos – Free Certification: Prior to final acceptance, the Contractor shall submit a signed statement, accompanied by SDS sheets for project materials, from a licensed asbestos inspector or the project architect or engineer, or officer of the company, proclaiming that no asbestos-containing building materials were used in the construction via Form 3000 for Government Approval.

11.3 Asbestos: During Phase 2 work should the Contractor encounter/suspect previously unidentified Asbestos Containing Material (ACM) that must be disturbed to comply with the contract documents, the Contractor shall cease all work which would disturb the suspect material and shall immediately notify TGC and 17 CES representative. Goodfellow AFB will take steps, as appropriate, to ascertain the material's composition and determine future actions necessary.

12. LEAD:

12.1. Under no circumstances, under the provisions of this contract, shall the Contractor be allowed to provide Lead Based Paint (LBP), paint products or lead building materials. The definition of Lead Based Paint is paint or other surface coating that contains lead to or in excess of 1.0 milligrams per square centimeter or more than .5% by weight (5000ppm).

12.2. No pipe or pipe fitting which contains more than 0.25% lead may be used for the installation or repair of plumbing at any connection which provides water for human use.

12.3. No solder or h contains more than 0.2% lead can be used for the installation or repair of plumbing at any connection which provides water for human use.

12.4 Lead Based Paint: During Phase 2 work should the Contractor encounter/suspect previously unidentified lead based paint that must be disturbed to comply with the contract documents, the Contractor shall cease all work that would disturb the suspect material and shall immediately notify TGC and 17 CES representative. Goodfellow AFB will take steps, as appropriate, to ascertain the material's composition and determine future actions necessary

13. RELEASE OF FLUIDS TO THE SANITARY SEWER SYSTEM:

13.1. Goodfellow AFB's sanitary sewer system discharges into the Publicly Owned Treatment Works (POTW) operated by the City of San Angelo, Texas. This POTW has established testing requirements for certain constituents as well as discharge limits of those same constituents. Accordingly, any Contractor performing work at Goodfellow AFB and contemplating a release of non-hazardous water into the sanitary sewer system shall comply with the testing/release requirements established by the City of San Angelo. The Contractor is also responsible for any and all testing, monitoring, measuring, documenting, etc. to prove compliance with same.

14. GREEN PROCUREMENT PROGRAM (GPP)

14.1. Green Procurement is defined as "The purchase of environmentally preferable products and services in accordance with Federally mandated "green" procurement preference programs.

14.2. Priority should be given to products that emphasize the source reduction aspect of the Air Force's Pollution Prevention hierarchy and those that incorporate one, or all, of the following mandatory GPP elements: Recovered Materials, Energy and Water Efficient, Alternate Fuels and Fuel Efficiency, Bio- based, Ozone Depleting Substances, Priority Chemicals, and Environmentally Preferable Products (EPP).

15. AIR EMISSION SOURCE REPORTING

15.1. The Contractor shall comprehend and comply with all applicable Federal, State, County and Municipal laws concerning air pollution, particularly the Clean Air Act (CAA) and all subsequent amendments. All work under this contract shall be performed in such a manner that objectionable or nuisance conditions will not be created in the air nor will objectionable particulates be released into the air.

16. CONSTRUCTION & DEBRIS

16.1. Construction and Demolition (C&D) debris consists of the waste generated during construction, renovation, and demolition projects. Covering a wide array of materials, this waste often contains bulky, heavy materials, including concrete, wood, asphalt (from roads and roofing shingles), gypsum (the main component of drywall), metals, bricks, plastics, and plant materials from site clearing. C&D debris also includes salvaged building components such as doors, windows, and plumbing fixtures.

16.2. When a project involves any type of construction, remodeling, or demolition, the Contractor shall use all means available to divert to the greatest extent practicable and economically feasible, construction and demolition waste from landfills. At the end of the project, and prior to final acceptance, the Contractor shall submit a solid waste diversion report (the form is included in this document Appendix B) identifying the materials and weights either recycled or diverted from solid waste disposal to other re-use as well as weights of waste disposed in a landfill. The report shall be submitted via AF Form 3000 to the Contracting Officer (forward to Environmental Office).

17. TRAINING

17.1. The Contractor shall ensure all employees complete the required Hazardous Communication (HAZCOM), Hazardous Materials and Hazardous Waste training required for this project. If hazardous materials are used and/or hazardous wastes are generated as part of this contract, then the Contractor shall appoint a primary and alternate HAZMAT and Hazardous Waste monitor. The Contractor is responsible for training all Contractor personnel regarding environmental aspects associated with the project.

18. ENVIRONMENTAL MANAGEMENT SYSTEM (EMS):

18.1. The Contractor's on-site supervisory personnel shall complete the EMS Awareness Training (EMS100AFIT00004) program prior to commencement of any activities. The Installation Environmental Office should be contacted at (325) 654-5946 for information about this 7-minute awareness training within 60 days of contract award or a new contract employee supervisor begins work. The training will be accomplished utilizing web-based The Environmental Awareness Course Hub (TEACH) available through any internet access at <https://usaf.learningbuilder.com/>

18.2. The training above will be tracked by the Environmental System Administrator.

Appendix A: Air Emission Source Reporting

Air Emission Source Reporting				
1. From:		2. 17 CES/CEIE 460 E. Kearney Blvd Bldg. 3511, Rm 130 Goodfellow AFB, Texas 76908		3. Month/Year Ending (mmm/yyyy)
4. PRODUCT	5. AMT RECEIVED	6. U/I	7. AMT USED	8. BALANCE
Fuels - Gasoline		Gallons		
Fuels - Diesel		Gallons		
Propane / LPG		Gallons		
Natural Gas		CU FT		
Welding rods/wire		Pounds		

9. REPORTED BY (Name, Orgn, Phone)		9a. DATE	10. ENTERED BY (Name, Orgn)	

Form Instructions:

- 1) Organization and address of organization and/or contractor providing the report
- 2) Organization and address of office receiving the report
- 3) Ending month and year for data being reported
- 4) Name of product being reported, for example JP8, Mogas, Diesel, etc.
- 5) Total quantity received in the reporting month
- 6) Unit of issue for the product reported – I.e., gallons, pounds
- 7) Total quantity issued or used in the reporting month
- 8) Balance of product – The end balance of unused materials that are still on the installation or transported off- site by a contractor.
- 9) Name, organization and phone number of person providing report
 - a. Date of report
- 10) Name of person performing data entry
 - a. Date of data entry

Appendix B: Construction & Demolition Debris

Material Type	Recycled (pounds)	Recycling Company	Landfill (pounds)	Landfill Used	Costs / Proceeds
Asphalt					
Bricks					
Concrete					
Dirt/Soil					
Dumpster Debris					
Freons/Refrigerants					
Light Bulbs					
Lumber/Wood					
Metals					
Oil/Petroleum					
Plastics					
Roofing					
Steel					
Wastewater					

Tress/Brush					
Other					

San Angelo Area Recycling Haulers and Markets:

Ric Abbott Co., 6577 S. US Hwy 277, San Angelo, TX (325) 651-7330
Acme Iron & Metal Co., 720 N. Buchanan, San Angelo, TX (325) 653-1407
Butts Recycling Inc., 615 W 11th St, San Angelo, TX (325) 653-8957

San Angelo Area Landfill

Republic Services Inc., 3002 Old Ballinger Hwy, San Angelo, TX (325) 655-6869 (7:00 AM -5:30 PM Mondays-Fridays / 7:00 AM -12:00 PM Saturdays / Closed Sundays)

END OF SECTION 014000

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
 2. Instruction of Owner's personnel.
 3. Final cleaning.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following: (list items below that are incomplete in request)
1. Prepare a list of items to be completed and corrected (punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications and similar documents.
 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Deliver tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.
 6. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 7. Complete startup testing of systems.
 8. Submit test/adjust/balance records.
 9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 10. Advise Owner of changeover in heat and other utilities.
 11. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 12. Complete final cleaning requirements, including touchup painting.
 13. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection to determine Substantial Completion. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit copy of Project Closeout Checklist of items to be completed or corrected (punch list), confirming each item has been completed or otherwise resolved for acceptance.
 2. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. Organize list of spaces in sequential order.
 - 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch-up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of

- diffusers, registers and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in light fixtures to comply with requirements for new fixtures.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR OPERATION AND MAINTENANCE MANUALS

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.
- B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- C. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Architect.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

- E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

2.2 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor is delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.

- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
- F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Demolition and removal of selected site elements.
 2. Salvage of existing items to be reused or recycled.

1.3 DEFINITIONS

- A. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 1. Inspect and discuss condition of construction to be selectively demolished.
 2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 3. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 4. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- B. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Submit to Government before work begins.

1.7 FIELD CONDITIONS

- A. Addition: Owner will occupy portions of building 3321 immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

Alteration: Owner will occupy portions of building 3321. All selective demolition shall be performed in a manner so as not to disrupt Fire Department operations. Refer to drawings for areas to be altered. Working hours for B3321 will be Monday – Friday, 0730 – 1700. Work needing to be performed during off hours and days shall be requested by the Contractor 72 hours in advanced prior to the hours and days being requested.

- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- D. Utility Service: Maintain existing utilities and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Survey of Existing Conditions: Record existing conditions by use of measured drawings preconstruction photographs or video and templates.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Outages: Any utility outages shall be requested in writing by the Contractor, 7 days prior to the expected outage. The outage shall be coordinated through the TGC rep and GAFB 17CES personnel.

3.3 PROTECTION

- A. Addition: Temporary Protection - Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect any exterior components of the existing building 3321 and gazebo adjacent to worksite.
- B. Alteration: Temporary Protection – Provide temporary plastic sheeting / dust barriers separating the occupied portions of building 3321.
 - 1. Provide signage noting “Danger – Construction Area” and “Alternate Route”
 - 2. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 3. Cover and protect furniture, furnishings, and equipment that have not been removed.
- C. Remove temporary barricades only when hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically. Before performing any existing roof demolition, coordinate with all parties to make aware of upcoming overhead work activity, safety, and duration.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Only if no other demolition/dismantling method is achievable, will the use of flame-cutting equipment be allowed. Do not use cutting torches until work area is cleared of flammable materials. Verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least 1 hour after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- D. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- F. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- G. Burning: Do not burn demolished materials.

3.7 CLEANING

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

END OF SECTION 02411

SECTION 033000 - CAST-IN-PLACE

CONCRETE PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent agency responsible for concrete design mixtures.
 - c. Independent lab agency responsible for testing concrete design mixtures.
 - d. Ready-mix concrete manufacturer.
 - e. Concrete Subcontractor.
 - f. Special concrete finish Subcontractor.
 - 2. Review special inspection, testing, and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Engineer.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.
- B. Welding certificates.
- C. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Aggregates.
- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Any material showing signs of damage because of improper handling will not be allowed for use. All stored materials shall be placed on dunnage and not allowed to rest on bare ground/soil. Any material showing signs of rust, rot/decay because of improper storage will not be allowed for use.

1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301.
 2. ACI 117.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
 - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.
 - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
 3. Overlaid Finnish birch plywood.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- F. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- G. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 1. Portland Cement: ASTM C 150/C 150M, Type I Type II or Type I/II, gray.
 2. Fly Ash: ASTM C 618, Class F or C.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- F. Water: ASTM C 94/C 94M and potable.

2.6 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 1. Maintain permeance of less than 0.01 Perms as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
 2. Meet "Peel adhesion to concrete" test as tested in accordance with ASTM D903.
 3. Thickness: 6 mils minimum, U.O.N. Refer to drawings

2.7 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ChemMasters, Inc.](#)
 - b. [SpecChem, LLC.](#)
 - c. [W.R. Meadows, Inc.](#)

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D 2240.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlay: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Slag Cement: 50 percent.

4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Grade Beams, Pier Caps, And Retaining Wall Footings: Normal-weight concrete.
1. Minimum Compressive Strength: As indicated on drawings.
 2. Maximum W/C Ratio: As indicated on drawings.
 3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
- B. Suspended Slabs: Normal-weight concrete.
1. Minimum Compressive Strength: As indicated in drawings.
 2. Maximum W/C Ratio: As indicated on the drawings.
 3. Minimum Cementitious Materials Content: 520 lb/cu. yd.
 4. Slump Limit: 4 inches, plus or minus 1 inch.
 5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.13 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support

weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beams and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.5 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, and slabs and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Structural Slabs: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawn Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

- D. Isolation Joints in Structural Slabs: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view.

- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 50; and of levelness, F(L) 40; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.10 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Construct concrete bases 4 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
 - 3. Minimum Compressive Strength: 4000 psi at 28 days.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
 - 6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENT APPLICATION

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply to concrete that is less than seven days' old.
 - 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least two month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles.

8. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 1. Steel reinforcement placement.
 2. Headed bolts and studs.
 3. Verification of use of required design mixture.
 4. Concrete placement, including conveying and depositing.
 5. Curing procedures and maintenance of curing temperature.
 6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
 5. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 10. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

SECTION 042000 UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Clay face brick.
 - 2. Mortar and grout.
 - 3. Masonry-joint reinforcement.
 - 4. Ties and anchors.
 - 5. Embedded flashing.
 - 6. Miscellaneous masonry accessories
- B. Products Installed but not Furnished under This Section:
 - 1. Steel lintels in unit masonry.
 - 2. Steel shelf angles for supporting unit masonry.
- C. Related Requirements:
 - 1. Section 072100 "Thermal Insulation" for cavity wall insulation.

1.3 DEFINITIONS – Not Applicable

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type and color of the following:
 - 1. Cast stone caps.
 - 2. Clay face brick.
 - 3. Weep holes and cavity vents.
 - 4. Water Repellent (Product Info)

1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for typical exterior wall typical exterior and interior walls in sizes approximately 72 inches long by 60 inches high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least 16 inches long in exterior wall mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
 - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include metal studs, sheathing, water-resistive barrier sheathing joint-and-penetration treatment, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
 - 2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 - 3. Clean exposed faces of mockups with masonry cleaner as indicated.
 - 4. Protect accepted mockups from the elements with weather-resistant membrane.

5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 UNIT MASONRY, GENERAL – Not Applicable

2.3 CONCRETE MASONRY UNITS – Not Applicable

2.4 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: hollow brick complying with ASTM C 652, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area).
1. Grade: **SW**
 2. Type: **FBS**
 3. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested according to ASTM C 67.
 4. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 5. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
 6. Provide face brick matching color range, texture, and size of the existing brickwork.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91/C 91M.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Cemex S.A.B. de C.V.](#)
 - b. [Essroc.](#)
 - c. [Holcim \(US\) Inc.](#)
 - d. [Lafarge North America Inc.](#)
 - e. [Lehigh Hanson; HeidelbergCement Group.](#)
- E. Mortar Cement: ASTM C 1329/C 1329M.
1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
 - a. [Lafarge North America Inc.](#)
- F. Aggregate for Mortar: ASTM C 144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
- G. Aggregate for Grout: ASTM C 404.
- H. Water: Potable.

2.6 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
- C. Adjustable Masonry-Veneer Anchors:
 - 1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
 - 2. Fabricate wire ties from 0.187-inch- diameter, hot-dip galvanized-steel wire unless otherwise indicated.
 - 3. Screw-Attached, Masonry-Veneer Anchors: 2x Wire tie and plate for securing insulation board in cavity.
 - 1) [Basis of Design: Hohmann & Barnard, Inc.](#), Basis of Design: Hohmann & Banard Inc, HB-213 adjustable veneer anchor with washer option to hold insulation board in place

2.7 EMBEDDED FLASHING MATERIALS

- A. Flexible Flashing: Use the following unless otherwise indicated:
 - 1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than **0.030 inch**.
 - a. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) [Advanced Building Products Inc.](#)
 - 2) [Fiberweb, Clark Hammerbeam Corp.](#)
 - 3) [Heckmann Building Products, Inc.](#)
 - 4) [Polyguard Products, Inc.](#)
 - 5) [W.R. Meadows, Inc.](#)
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- B. Application: Unless otherwise indicated, use the following:
 - 1. Where flashing is indicated to receive counterflashing, use metal flashing.
 - 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 - 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use flexible flashing with a metal sealant stop.
 - 4. Where flashing is fully concealed, use flexible flashing.
- C. Solder and Sealants for Sheet Metal Flashings:
 - 1. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.
- E. Termination Bars for Flexible Flashing: Aluminum bars 1/8 inch by 1 inch.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Weep/Cavity Vent Products: Use the following unless otherwise indicated:
 - 1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.

- B. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Advanced Building Products Inc.](#)
 - b. [Heckmann Building Products, Inc.](#)
 - c. [Mortar Net Solutions.](#)
 - 2. Configuration: Provide one of the following:
 - a. Strips, full depth of cavity and 10 inches high, with dovetail-shaped notches 7 inches deep that prevent clogging with mortar droppings.

2.9 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufactures offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Diedrich Technologies, Inc.; a Hohmann & Barnard company.](#)
 - b. [EaCo Chem, Inc.](#)
 - c. [PROSOCO, Inc.](#)

2.10 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 - 1. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

2.11 WATER REPELLENT

- A. Water repellent solution shall be a clear, non-yellowing, deep-penetrating, VOC compliant solution. Product shall not stain or discolor and shall produce a mechanical and chemical interlocking bond with the substrate to the depth of the penetration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- D. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
 - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
 - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
 - 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2-inch maximum.
 - 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
- C. Joints:
 - 1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
 - 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 - 3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
 - 4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 - 5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Match existing.
- C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
 - 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 CAVITY WALLS

- A. Bond wythes of cavity walls together as follows:
 - 1. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - 2. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Embed tie sections in masonry joints.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 25 inches o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

- B. Provide not less than 2 inches of airspace between back of masonry veneer and face of sheathing.
 - 1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form expansion joints in brick as follows:
 - 1. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under water-resistive barrier, lapping at least 4 inches. Fasten upper edge of flexible flashing to sheathing through termination bar.
 - 3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 - 4. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
 - 1. Use specified weep/cavity vent products to form weep holes.
 - 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 - 3. Space weep holes 24 inches o.c. unless otherwise indicated.
 - 4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
- D. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- E. Install cavity vents in head joints in exterior wythes at 24 inch o.c. Use specified weep/cavity vent products to form cavity vents.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform

appearance. Prepare joints for sealant application, where indicated.

- B. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
 - 7. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.12 MASONRY SURFACES

- A. Water Repellent Treatment: Do not apply water repellent treatment until all joint tooling, pointing, and masonry cleaning have been completed. Allow masonry to cure for 60 days under normal weather conditions before applying water repellent.
 - 1. Prepare all exterior substrates/surfaces in accordance with water treatment manufacturer's recommendation. Clean surfaces of dust, dirt, efflorescence, alkaline, and foreign matter for proper application of treatment.
 - 2. Protection: Mask and/or shield all surfaces not receiving treatment and that could potentially be damaged by repellent. Follow manufacturers recommendations.
 - 3. Apply water repellent treatment with brush, roller, or sprayer at a rate as recommended by the manufacturer.
 - 4. Apply as many number of coats required to achieve full coverage and protection.
 - a.) Sample section should be applied to mock-up to determine number of applications.
 - 5. Clean all runs, drips, and/or overspray from surfaces while water repellent treatment is still wet.

3.13 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1.0 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Structural steel.
 - 2. Field-installed shear connectors.
 - 3. Grout.
- B. Related Requirements:
 - 1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
 - 2. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
 - 3. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for surface-preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment Drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
 - 5. Identify members and connections of the Seismic-Load-Resisting System.

6. Indicate locations and dimensions of protected zones.
7. Identify demand critical welds.

- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
1. Power source (constant current or constant voltage).
 2. Electrode manufacturer and trade name, for demand critical welds.

1.7 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- C. Mill test reports for structural steel, including chemical and physical properties.
- D. Product Test Reports: For the following:
1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Shop primers.
 5. Nonshrink grout.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
 2. AISC 360.
 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2.0- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Moment Connections: Type FR, fully restrained.
- B. Construction: Combined system of moment frame and braced frame.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M.
- B. Channels, Angles: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C, structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
 - 1. Weight Class: Standard.
 - 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip or mechanically deposited zinc coating.
 - 2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436, Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- F. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.
 - 1. Nuts: ASTM A 563 heavy-hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436, Type 1, hardened carbon steel.
 - 4. Finish: Plain.
- G. Threaded Rods: .
 - 1. Nuts: ASTM A 563hex carbon steel.
 - 2. Washers: carbon steel.
 - 3. Finish:

2.4 PRIMER

- A. Primer: Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

- B. Primer: SSPC-Paint 25, Type II, zinc oxide, alkyd, linseed oil primer.
- C. Primer: SSPC-Paint 25 BCS, Type II, zinc oxide, alkyd, linseed oil primer.
- D. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- E. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.5 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."
- F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened, unless specifically noted otherwise in contract drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.

4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform shop tests and inspections.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 3. Ultrasonic Inspection: ASTM E 164.
 4. Radiographic Inspection: ASTM E 94.
- D. Prepare test and inspection reports.

PART 3.0 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and

- B. Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened, unless specifically noted otherwise in the contract drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor will engage a qualified special inspector to perform the following special inspections:
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- C. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.

- b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
- c. Ultrasonic Inspection: ASTM E 164.
- d. Radiographic Inspection: ASTM E 94.

3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof deck.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
 - 2. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings:
 - 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Evaluation Reports: For steel deck, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ROOF DECK

- A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, **G60** zinc coating.
 - 2. Deck Profile: Type WR, wide rib.
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: **As indicated.**
 - 5. Span Condition: Triple span or more.
 - 6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, **0.0747 inch** thick, with factory-punched hole of 3/8-inch minimum diameter.
- H. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and **level** recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: ASTM A 780/A 780M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Locate deck bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members as indicated in drawings.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, as indicated in drawings.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: **Lapped 2 inches minimum or butted at Contractor's option.**
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

3.5 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior non-load-bearing wall framing.
 - 2. Roof rafter framing.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
 - 2. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.6 QUALITY ASSURANCE

- A. Product Tests: Mill certificates or data from a qualified independent testing agency.
 - 1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
 - 1. Floor and Roof Systems: AISI S210.
 - 2. Wall Studs: AISI S211.
 - 3. Headers: AISI S212.
 - 4. Lateral Design: AISI S213.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 - 1. Grade: **As indicated.**
 - 2. Coating: **G60, A60, AZ50, or GF30.**

- B. Steel Sheet for **Vertical Deflection** Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: **As** indicated.
 - 2. Coating: **G60**.

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: As indicated on drawings.
 - 2. Flange Width: As indicated on drawings.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: **Matching steel studs or as indicated on drawings.**
 - 2. Flange Width: As indicated on drawings.
- C. Vertical Deflection Clips: Manufacturer's standard **head** clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs or as indicated on drawings.
 - 2. Flange Width: **1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.**
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 ROOF-RAFTER FRAMING AT ROOF OVERBUILD

- A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: As indicated on drawings.
 - 2. Flange Width: As indicated on drawings.

2.5 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated.

2.6 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780/A 780M, MIL-P-21035B, or SSPC-Paint 20.
- B. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
- D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- E. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- F. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- G. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to **top and** bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: **As indicated on Drawings**

- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Connect vertical deflection clips to **infill** studs and anchor to building structure.
 - 3. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated **on Shop Drawings** but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 FIELD QUALITY CONTROL

- A. Testing: Contractor will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing agency will report test results promptly and in writing to Contractor and Architect.
- C. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

3.7 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold- formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal ladders.
 - 2. Non-slip exterior stair nosing.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
 - 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 - 3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- C. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
 - 2. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
 - 3. Section 051200 "Structural Steel Framing."

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following: Not Applicable
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 – PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.2 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.3 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Prime miscellaneous framing and supports with zinc-rich primer.

2.4 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.
- C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.2 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1.0 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section covers general exterior and interior rough carpentry.
- B. The publications listed below form a part of this specification. The publications are referred to in the text by the basic designation only. All referenced publications shall be the most current edition in effect on the date of solicitation.

1. FEDERAL SPECIFICATIONS [FS]

- a. FF-N-105B - Nails, Brads, Staples, and Spikes: Wire, Cut and Wrought

2. U.S. Department of Commerce, National Bureau of Standards, Product Standards (PS)

- a. PS1 - Construction and Industrial Plywood
b. PS20 - American Softwood Lumber Standard

3. American National Standards Institute (ANSI) Publication

- a. A 135.4 - Basic Hardboard

4. American Plywood Association (APA)

Design/Construction Guide Residential and Commercial
Performance Standards and Policies for Structural-Use Panels
Product Guide: Performance-Rated Panels

- a. AFG-01 - Adhesives for Field-Gluing Plywood to Wood Framing

5. American Society for Testing and Materials (ASTM)

- a. ASTM A 307 - Carbon Steel Bolts and Studs

6. AMERICAN WOOD PRESERVERS ASSOCIATION

- a. C 1 - All Timber Products Preservative Treatment by Pressure Process
b. C 20 - Structural Lumber Fire Retardant Treatment by Pressure Process

7. NATIONAL FOREST PRODUCTS ASSOCIATION [NFPA]

National Design Specification for Wood Construction (Current Edition)

- a. SOUTHERN PINE INSPECTION BUREAU [SPIB]

- Grading Rules

- b. WESTERN WOOD PRODUCTS ASSOCIATION [WWPA]

- Western Lumber Grading Rules

1.3 GENERAL REQUIREMENTS:

- A. Grading And Marking: Materials shall bear the grade mark, stamp, or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on a material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standard's Committee, to grade species used. Except for structural glued laminated members, plywood, and lumber; bundle marking or certificates will be permitted in lieu of marking each individual piece.
- B. Sizes: Lumber sizes shall conform to Prod. Std. PS 20, and unless otherwise specified, lumber shall be surfaced on four sides. Sizes for materials other than lumber shall conform to requirements of the rules or standards under which produced. Size references, unless otherwise specified are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.
- C. Moisture Content: At the time lumber and other materials are delivered and when installed in the work, their moisture content shall be as follows:
 - 1. Treated and Untreated Lumber 2 Inches or Less in Thickness: 19 percent maximum.
 - 2. Treated and Untreated Lumber over 2 Inches in Thickness: 25 percent maximum.
 - 3. Materials Other Than Lumber: In accordance with standard under which product is produced.

1.4 SUBMITTALS: [Not Applicable]

1.5 DELIVERY AND STORAGE:

- A. Materials shall be delivered to the site in undamaged condition, stored in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

PART 2.0 - PRODUCTS

2.1 MATERIALS: Materials shall conform to the following requirements:

- A. Accessories and Nails:
 - 1. Anchor Bolts: ASTM A 307, size as indicated, complete with nuts and washers.
 - 2. Expansion Shields: Type and size best suited for intended use.
 - 3. Bolts; Lag, Toggle, and Miscellaneous Bolts and Screws: Type, size, and finish best suited for intended use.
 - 4. Sleeper Clips: Galvanized steel appropriate for use.
 - 5. Clip Angles: Steel, 3/16-inch thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.
 - 6. Nails and Staples: Size and type best suited for purpose, in accordance with FS FF-N-105 when applicable to type used. In general, 8-penny or larger nails shall be used for nailing through nominal 1-inch thick lumber and for toe nailing nominal 2-inch thick lumber; 16-penny or larger nails shall be used for nailing through nominal 2-inch thick lumber.

2.2 Miscellaneous Wood Members:

- A. Nonstress Graded Members: Members shall include plates, caps, bucks, studs, blocking, nailers, sleepers, and grounds. Members shall be standard grade or No. 2 grade except studs may be stud grade. Nonstress member grades shall conform to the National Grading Rule for Dimension Lumber established in conformance with Prod. Std. PS 20 and as applied in individual grading rules of applicable grading agencies. For species graded under

other grading rules, grade used shall be equivalent to grades outlined above. Sizes shall be as follows unless otherwise shown:

<u>Member</u>	<u>Size (inches)</u>
Corner bracing	1 x 4
Furring	1 x 3
Grounds	Material thickness x 1-1/2.
Nailing strips	1 x 3 when used as shingle base or interior finish, otherwise 2-inch stock.

B. General Use Plywood: Prod. Std. PS 1, C-D Exterior grade and thickness as shown.

C. Adhesive: APA Specification AFG-01.

PART 3.0 - EXECUTION

- 3.1 General: Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Nailing shall be in accordance with the Recommended Nailing Schedule as contained in NFPA Manual for House Framing. Where detailed nailing requirements are not specified, nail size and nail spacing shall be sufficient to develop an adequate strength for the connection without splitting the members. Installation of timber connectors shall conform to applicable requirements of the NFPA National Design Specification for Wood Construction. Rafters, purlins, and joists shall be set with crown edge up. Leveling of joists, beams, and girders on masonry or concrete shall be with slate or steel; on wood or metal leveling shall be without shims.
- 3.2 Framing: Except where otherwise indicated joists shall have bearings not less than 1-1/2 inches on studs. Joists, trimmers, headers, and beams framing into carrying members at the same relative levels shall be carried on joist hangers. Joists shall be lapped and clinched at bearings or butted end-to-end with scab ties at joint and spiked to plates. Openings shall be framed with headers and trimmers. Headers carrying more than two tail joists and trimmers supporting headers carrying more than one tail joist shall be doubled, unless otherwise indicated.
- 3.3 Nailers and Nailing Strips: Nailers and nailing strips shall be provided as necessary for the attachment of finish materials. Nailers used in conjunction with roof deck installation shall be installed flush with the roof deck system. Strips shall be run in lengths as long as practicable, butt jointed, cut into wood framing members when necessary, and rigidly secured in place.
- 3.4 Wood Sleepers: Wood sleepers shall be run in lengths as long as practicable and butt jointed with end joints in adjacent rows staggered.
- 3.5 Furring Strips: Furring strips shall be provided at the locations shown. Furring strips shall be installed at 16 inches on center unless otherwise shown, run in lengths as long as practicable, butt jointed, and rigidly secured in place.
- 3.6 Rough Bucks and Frames: Rough bucks set straight, true, and plumb, and secured with anchors near top and bottom of each wood member and at intermediate intervals of not more than 3 feet. Anchors for concrete shall be expansion bolts, and anchors for masonry shall be 3/16-inch by 1-1/4 inch steel straps extending not less than 8 inches into the masonry and turned down 2 inches into the masonry.
- 3.7 General Use Plywood: Plywood shall be installed where indicated.

TABLE 1

SPECIES AND GRADE

Grading Rules	Species	Const Stand.	Comm	No. 2 Board	No. 2 Comm	No. 3 Comm
NHLA	Cypress				X	
NELMA	Northern White Cedar					X
	Eastern White Pine		X			
	Northern Pine		X			
	Balsam Fir					X
	Eastern Hemlock					X
	Tamarack					X
CRA	Redwood			X		
SCMA	Cypress				X	
SPIB	Southern Pine			X		
WCLIB	Douglas Fir-Larch	X				
	Hem-Fir		X			
	Sitka Spruce					X
	Mountain Hemlock					X
	Western Cedar					X
WWPA	Douglas Fir-Larch					X
	Hem-Fir	X				
	Idaho White					X
	Lodgepole Pine				X	
	Ponderosa Pine				X	
	Sugar Pine					X
	Englemann Spruce					X
	Douglas Fir South					X
	Mountain Hemlock					X
	Subalpine Fir					X
	Western Cedar					X

END OF SECTION 061000

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
- B. Related Requirements:
 - 1. Section 072500 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.4 QUALITY ASSURANCE

- A. Mockups: See Section 042000 UNIT MASONRY for components that will need to be installed for the exterior wall mockup.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Continental Building Products, LLC.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. Temple-Inland Building Products by Georgia-Pacific.
 - f. USG Corporation.
 - 2. Type and Thickness: Regular, 1/2" or 5/8" inch thick.
 - 3. Size: 48 by 96 inches for vertical installation.

2.2 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

2.3 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
- D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
- D. Seal sheathing joints according to sheathing manufacturer's written instructions.
 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.3 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

END OF SECTION 061600

SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section covers general exterior and interior finish carpentry.

1.3 APPLICABLE PUBLICATIONS: (Latest editions)

- 1. Federal Specification (FS):
 - a. FF-N-105B - Nails, Brads, Staples and Spikes: Wire, Cut and Wrought
- 2. U.S. Department of Commerce, Product Standard (PS):
 - a. PS 1 - Construction and Industrial Plywood
 - b. PS 20 - American Softwood Lumber Standard
- 3. American National Standards Institute (ANSI) Publication:
 - a. A135.6 - Hardboard Siding
- 4. American Society for Testing and Materials (ASTM) Publications:
 - a. A 307 - Carbon Steel Bolts and Studs
- 5. Architectural Woodwork Institute (AWI) Publication:
 - a. Architectural Woodwork Quality Standards, Guide Specifications and Quality Certification Program (1994)

1.4 GENERAL REQUIREMENTS:

- A. Grading and Marking: Materials shall bear the grade-mark, stamp or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on a material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Except for plywood and lumber, bundle marking or certificates will be permitted in lieu of marking each individual piece.
- B. Sizes and Patterns: Lumber sizes and patterns shall conform to Prod. Std. PS 20, and unless otherwise specified, shall be surfaced on four sides. Sizes and patterns for materials other than lumber shall conform to requirements of the rules or standards under which produced. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.
- C. Moisture Content: The maximum moisture content of treated and untreated trim and wood siding shall be 12 percent at the time of delivery to the job site and when installed. Moisture content of all other materials shall be in accordance with the standard under which the product is produced.

1.5 SUBMITTALS:

- A. Shop Drawings: Shop drawings of fabricated items, special mill items, and woodwork items shall be submitted for approval in accordance with the SECTION 01300: PROJECT SUBMITTALS. Shop drawings shall indicate materials and details of construction, methods of fastening, and erection and installation details.
- B. Samples and Descriptive Data: Samples and descriptive data shall be submitted for approval. Samples shall be of sufficient size to show pattern, color range, and type, as applicable.

1.6 DELIVERY AND STORAGE:

- A. Materials shall be delivered to the site in undamaged condition, stored in fully covered, well-ventilated areas, and protected from extreme changes in temperature and humidity.

PART 2.0 - PRODUCTS

2.1 MATERIALS:

- A. Nails: Size and type best suited for the project requirements, hot dip galvanized or aluminum for exterior use, in accordance with FS FF-N-105 when applicable.
- B. Adhesives: Use manufactures recommended adhesives for each application being performed.
- C. Shelving: Shelving shall be a suitable species equal to or exceeding the requirements of No. 3 solid common white fir, 1 inch thick; or plywood, interior type Grade A-B, ¾" thick, PG, plywood, by 11 ¼" wide. Refer to architectural drawings for location and quantity.
- D. Plywood Backboards (Telecomm): Backboards shall comply with TIA-569-C. Backboards must be fire-retardant-treated wood, bearing the manufacturer's stamp. If painted, the manufactures fire rated stamp must remain visible. Cover a minimum of two adjacent walls with backboards. When renovating an existing TR that does not have adequate space, size the backboard as large as possible to accommodate wall mounted equipment.
- E. Casework: Casework shall be fabricated with a lumber core, glued and screwed to form an integral unit. Bond laminated plastic under pressure to exposed surfaces using a manufacturer recommended adhesives. Provide a backing sheet to those areas not having an exposed finish surface.
- F. Countertops: Solid surface countertops. Refer to Section 066116, Solid Surfacing Fabrication

PART 3 - EXECUTION

3 INSTALLATION:

- A. Room Closets: Support shelving material with heavy duty steel closet rod shelf bracket as indicated. Provide full length, wood or metal clothes hanger rod. Refer to drawings for construction details.

END OF SECTION 062000

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
- C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Field quality control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: ANSI/ KCMA A161.1 Compliance Program certificates.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
 - 1. Manufacturer's Certification: Produces cabinets bearing the ANSI/ KCMA 161.1 certification.
- B. Installer Qualifications: Manufacturer of products.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Type of Construction: Frameless.
- D. Door Front Style: Flush overlay.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Abet Laminati Inc.](#)
- b. [Formica Corporation.](#)
- c. [Lamin-Art, Inc.](#)
- d. [Pionite: a Panolam Industries International, Inc. brand.](#)
- e. [Wilsonart LLC.](#)

- F. Laminate Cladding for Exposed Surfaces:
1. Horizontal Surfaces: Grade HGS.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: Grade VGS.
 4. Edges: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
 5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- H. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As indicated in drawings. Laminate to have a scratch resistance surface and aligned texture.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Wood Moisture Content: 5 to 10 percent.
 2. Underlayments for plastic laminate to be $\frac{3}{4}$ " Medium Density Fiberboard. All other components for Millwork shall be $\frac{3}{4}$ " thick plywood or hardwood.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087100 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.
- C. Back-Mounted Pulls: BHMA A156.9, B02011.
- D. Wire Pulls: Back mounted, solid metal, 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.
- E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
- F. Door Silencers: BHMA A156.16, L03011.
- G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Dark, Oxidized, Satin Bronze, Oil Rubbed: BHMA 613 for bronze base; BHMA 640 for steel base.
- H. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 10 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesive: Do not use adhesives that contain urea formaldehyde.

2.5 FABRICATION

- A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.
- B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors fit openings and are accurately aligned. Adjust hardware to center doors in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.2 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through ANSI/KCMA A161.1 certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
 - 1. Inspection entity shall prepare and submit report of inspection.

END OF SECTION 064116

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Extruded polystyrene foam-plastic board.
 - 2. Polyisocyanurate foam-plastic board.
 - 3. Glass-fiber blanket.
 - 4. Loose-fill insulation.
- B. Related Requirements:
 - 1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
 - 2. Section 061600 "Sheathing" for foam-plastic board sheathing installed directly over wood or steel framing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET

- A. Glass-Fiber Blanket, Unfaced at Exposed Locations and at Interior Partitions Indicating Sound Attenuation blankets: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [CertainTeed Corporation.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)
 - d. [Owens Corning.](#)
- B. Glass-Fiber Blanket, Kraft Faced at Exterior Walls: ASTM C 665, Type II (nonreflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [CertainTeed Corporation.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)

- d. [Owens Corning.](#)
- 2. Thermal Properties: R=19.
- C. Glass-Fiber Blanket, Polypropylene Scrim Kraft (PSK) Faced at Roof between purlins: ASTM C 665, Type II, Class A, Category 1 (membrane is a vapor barrier).
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [CertainTeed Corporation.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)
 - d. [Owens Corning.](#)
 - 2. Thermal Properties: R-30

2.2 INSULATION FASTENERS

- A. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [AGM Industries, Inc.](#)
 - b. [Gemco.](#)
- B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [AGM Industries, Inc.](#)
 - b. [Gemco.](#)

2.3 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer. Fit courses of insulation between wall ties and other

obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.4 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward interior of construction.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072400 – EXTERIOR INSULATION and FINISH SYSTEMS

PART 1 – GENERAL

Channeled Adhesive CI Design Wall System

General: The system shall be installed in strict accordance with current recommended published details and product specifications from the system's manufacturer.

Technical Information

Consult manufacturers technical services department for specific recommendations concerning all other applications. Consult the manufacturers website, for additional information about products, systems and for updated literature.

- A. Wind Load
1. Maximum deflection not to exceed $L/240$ of span under positive or negative design loads unless otherwise approved in writing by the material provider.
 2. Design for wind load in conformance with local code requirements.
- B. Substrate Systems
1. Acceptable substrates are: PermaBase® Cement Board and other cement-boards conforming with ASTM C1325 (Type A-exterior); poured concrete/unit masonry; ASTM C1177 type sheathings, including, Weather Defense™ Platinum sheathing, GreenGlass® sheathing, eXP™ sheathing, GlasRoc® sheathing, Securock™ glass-mat sheathing, and DensGlass® exterior sheathing DensElement (sheathing only); gypsum sheathing (ASTM C79/C1396); Huber Zip (sheathing only) Exposure I or exterior plywood (Grade C/D or better); or Exposure I OSB.
 2. Painted and otherwise coated surfaces of brick, unit masonry, stucco and concrete shall be inspected and prepared, approved, before application. The applicator shall verify that the proposed substrate is acceptable prior to the Channeled Adhesive CI Design Wall System installation.
 3. The substrate systems shall be engineered with regard to structural performance.
- C. Moisture Control
1. Prevent the accumulation of water behind the EIFS, either by condensation or leakage through the wall construction, in the design and detailing of the wall assembly.
 - a. Provide flashing to direct water to the exterior where it is likely to penetrate components in the wall assembly, including, above window and door heads, beneath window and door sills, at roof/wall intersections, decks, abutments of lower walls with higher walls, above projecting features, and at the base of the wall and anywhere else required by local code.
 - b. Air Leakage Prevention: Provide continuity of air barrier system at foundation, roof, windows, doors and other penetrations through the system with connecting and compatible air barrier components to minimize condensation and leakage caused by air movement.
 - c. Vapor Diffusion and Condensation: Perform a dew point analysis of the wall assembly to determine the potential for accumulation of moisture in the wall assembly as a result of water vapor diffusion and condensation. Adjust insulation thickness and/or other wall assembly components accordingly to minimize the risk of condensation. Avoid the use of vapor retarders on the interior side of the wall in warm, humid climates.
- D. Impact Resistance: Provide impact resistance to a minimum height of 6' (1.8m) above finished grade at all areas accessible to pedestrian traffic and other areas exposed to abnormal stress or potential impact. Indicate the areas with impact resistance requirements other than "Standard" on contract drawings.
- E. Color Selection: The use of dark colors must be considered in relation to wall surface temperature as a function of local climate conditions. Select Finish Coat color with a light reflectance value (LRV) of 20% or higher. The use of dark colors (LRV less than 20%) is not recommended with EIFS that incorporate expanded polystyrene (EPS). EPS has a sustained service temperature limitation of approximately 160°F (71°C).
- F. System Joints
1. Typical locations for system expansion joints are at building expansion joints, at prefabricated panel joints, floor lines of wood frame construction or where slip tracks are used in steel frame construction, where substrates change and where structural movement is anticipated. It is the sole responsibility of

- the project design team, including the architect, engineer, etc., to ultimately determine specific expansion joint placement, width and design. Detail specific locations in construction drawings.
2. Sealant joints are required at all penetrations through the wall system (windows, doors, etc.)
 3. Specify compatible closed cell backer rod and acceptable sealant that has been evaluated in accordance with ASTM C 1382, "Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish System (EIFS) Joints," and that meets minimum 50% elongation after conditioning.
 4. The system must be properly terminated (back wrapped a min. of 2", properly sealed, flashed) at all penetrations, lighting fixtures, electrical outlets, hose bibs, dryer vents, etc.
- G. Grade Condition: The Channeled Adhesive CI Design Wall System is not intended for use below grade or on surfaces subject to continuous or intermittent immersion in water or hydrostatic pressure. Ensure a minimum 8" (203.2 mm) clearance above grade or as required by code, a minimum 1" (25.4mm) clearance above finished grade (sidewalk/concrete flatwork).
- H. Trim, Projecting Architectural Features
1. Minimum slope for all projections shall be 1:2 (27°) with a maximum length of 12" (30.5 cm) [6" in 12" (e.g. 15 cm in 30.5 cm)]. Increase slope for northern climates to prevent accumulation of ice/snow on the surface.
- I. Coordination with other trades
1. Evaluate adjacent materials such as windows, doors, etc. for conformance to manufacturer's details. Adjacent trades shall provide scaled shop drawings for review.
 2. Air seals at any joints/gaps between adjoining components (penetrations, etc.) are of primary importance to maintain continuity of an air barrier system and must be considered by the design professional in the overall wall assembly design. Install air seals between the primary air/water-resistive barrier and other wall components (penetrations, etc.) in order to maintain continuity of an air barrier system.
 3. Provide site grading such that wall system terminates a minimum of 8" (203 mm) above finished grade or as required by code.
 4. Provide protection of rough openings in accordance with Air/Water-Resistive/Vapor Barrier Application Guidelines before installing windows, doors, and other penetrations through the wall.
 5. Install copings and sealant immediately after installation of the wall system and when coatings are completely dry.
- 1.1 RELATED DOCUMENTS
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 SUMMARY
- A. Section Includes:
1. Refer to all drawings and other sections of this specification to determine the type and extent of work therein affecting the work of this section, whether or not such work is specifically mentioned herein.
 2. Channeled Adhesive CI Design Wall System: Composite wall Exterior Insulation and Finish System consisting of air/water-resistive barrier, adhesive, rigid insulation, base coat, reinforcing mesh, and finish coat (all materials must be provided by the same manufacturer).
 3. Products are listed in this specification to establish a standard of quality. Any substitutions to this specification shall be submitted to and receive approval from the Architect at least 10 days before bidding. Proof of equality shall be borne by the submitter.
 4. The system type shall be a Channeled Adhesive CI Design Wall System.
- B. Related Requirements:
1. Section 03 00 00 Concrete substrate
 2. Section 04 00 00 Masonry substrate
 3. Section 05 40 00 Cold-formed metal framing
 4. Section 06 16 00 Sheathing
 5. Section 06 11 00 Wood framing
 6. Section 07 27 00 Air barriers
 7. Section 07 62 00 Sheet Metal Flashing and Trim
 8. Section 07 65 00 Flexible flashing
 9. Section 07 90 00 Joint protection
 10. Section 08 00 00 Openings

11. Section 09 22 00 Supports for plaster and gypsum board
12. Section 09 22 16 Non-structural metal framing
13. Section 09 29 00 Gypsum board

1.3 ACTION SUBMITTALS

1. Submit under provisions of Section [01 33 00]
2. Product Data: Provide data on Channeled Adhesive CI Design Wall System materials, product characteristics, performance criteria, limitations and durability.
3. Code Compliance : Provide manufacturer's applicable code compliance report.
4. Samples: Submit **[two] [x] [millimeter] [inch]** size samples of Channeled Adhesive CI Design Wall System illustrating finish coat color and texture range.
5. Certificate: System manufacturer's approval of applicator.
6. Sealant: Sealant manufacturer's certificate of compliance with ASTM C1382.
7. System manufacturer's current specifications, typical details, system overview and related product literature which indicate preparation required, storage, installation techniques, jointing requirements and finishing techniques.

1.4 DELIVERY, STORAGE, AND HANDLING

1. Deliver, store and handle products under provisions of Section [01 65 00] [01 66 00]
2. Deliver materials in original unopened packages with manufacturer's labels intact.
3. Protect materials during transportation and installation to avoid physical damage.
4. Store materials in cool, dry place protected from freezing. Store at no less than 40°F/4°C.
5. Store liquid flashing at a minimum of 40F. In cold weather, keep containers at room temperature for at least 24 hours before using.
6. Store insulation boards flat and protected from direct sunlight and extreme heat.
7. Store reinforcing mesh, sheathing fabric and flexible flashing in cool, dry place protected from exposure to moisture.

1.5 SITE CONDITIONS

1. Do not apply material in ambient temperatures below 40°F/4°C. Provide properly vented, supplementary heat during installation and drying period when temperatures less than 40°F/4°C prevail.
2. Do not apply materials to frozen surfaces.
3. Maintain ambient temperature at or above 40°F/4°C during and at least 24 hours after wall system installation and until dry.

1.6 WARRANTY

1. Provide manufacturers standard warranty for wall system installations under provisions of Section [01 70 00].
2. Comply with manufacturers project review requirements and notification procedures to assure qualification for warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Master Builders Solutions.](#)
 - b. [Dryvit Systems Inc.](#)
 - c. [Sto Corp.](#)

2.2 MATERIALS

- A. Air/Water-Resistive Barrier Components:
 1. Air/Water-Resistive Barrier: A one-component fluid-applied vapor permeable air/water-resistive barrier.
 2. Rough Opening and Joint Treatment: A one-component elastomeric material for use as a flexible flashing membrane.
 3. Transitional Membrane / Expansion Joint Flashing: A 20-mil thick self-adhering and self-sealing composite membrane of polyester fabric and butyl adhesive.

- B. Adhesives/Base Coats:
 - 1. Base Coat: A 100% acrylic base coat, water-resistant, field-mixed with Type I or Type II Portland cement.
- C. Portland cement: Conform to ASTM C150, Type I, II, or I/II, grey or white; fresh and free of lumps.
- D. Water: Clean and potable without foreign matter.
- E. Insulation Board: Expanded polystyrene; ASTM C578, Type I; Flame spread less than 25, smoke developed less than 450 per ASTM E84, UL 723.
 - 1. Minimum density 0.90 lb./ft³ ; K= 0.24 per inch (6.09 per mm).
 - 2. Minimum thickness as indicated on drawings [minimum 3/4" (19 mm).
 - 3. Air-dried (aged) six weeks, or equivalent, prior to installation.
 - 4. Edges: square within 1/32" per foot (0.8 mm per meter).
 - 5. Thickness: tolerance of plus or minus 1/16" (1.6 mm).
 - 6. Size: 2' x 4' (0.6 m x 1.22 m).
 - 7. Length and width: tolerance of plus or minus 1/16" (1.6 mm).
- F. Reinforcing Mesh: Balanced, open-weave glass, fiber reinforcing mesh, twisted multi-end strands treated for compatibility base coats.
 - 1. Intermediate weight, 12 oz.
 - 2. Corner mesh: Intermediate weight, pre-marked for easy bending, for reinforcing at exterior corners.
- G. Color Coat: A 100% acrylic-based coating. Designed for spray-, roller- or brush-application over EIFS with minimum change in finish texture or sheen.
- H. Tinted Primer: A 100% acrylic-based primer that helps alleviate shadowing. Color to closely match the selected finish coat color.
- I. Finish Coat:
 - 1. Finish: 100% acrylic polymer finishes with advanced technology to improve long-term performance and dirt pick-up resistance; air cured, compatible with base coat.

2.3 ACCESSORIES

- A. Window/Door Drip Edge: Rigid polyvinyl chloride (PVC), UV resistant for exterior use, with a drip Insulation edge, as furnished by an approved manufacturer. Accessories shall conform to ASTM D1784-97, C1063-99 and D4216-99. Provided accessories shall be able to withstand the regional climate of the project work site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect all surrounding areas and surfaces from damage and staining during application of wall system materials.
- B. Finish: Protect finished work at end of each day to prevent water penetration.
- C. Substrate preparation: Prepare substrates in accordance with manufacturers instructions. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 MIXING

General: All products requiring to be mixed for use, shall follow the manufactures mixing instructions and recommendations. No additives are permitted unless specified in product mixing instructions. Close containers when not in use. Prepare in a container that is clean and free of foreign substances. Do not use a container which has contained or been cleaned with a petroleum-based product.

3.3 APPLICATION

General: All materials to be installed, shall follow the manufactures application/installation instructions and recommendations. Under no circumstances shall the contractor deviate from the application/installation instructions without approval from the manufacturer and the contracting representative.

A. Accessories:

1. Attach Window/Door Drip Edge level and per manufacturer's instructions.

B. Air/Water-Resistive Barrier:

1. All sheathing joints and windows/openings must be protected, and the air/water-resistive barrier Applied in accordance with Air/Water-Resistive/Vapor Barrier Application Guideline technical bulletin.
2. Substrate shall be dry, clean, sound, and free of releasing agents, paint, or other residue or coatings. Verify substrate is flat, free of fins or planar irregularities greater than 6.4 mm in 3 m (¼" in 10').
3. Unsatisfactory conditions shall be corrected before application of the air/water-resistive barriers.
4. Apply the sheathing fabric and air/water-resistive barrier in accordance with the air/water-resistive barrier product bulletin.
5. Apply the flashing membrane in accordance with the product bulletin.
6. Installed materials shall be checked before continuing system application.
7. Ensure sheathing fabric and air/water-resistive barrier or flashing membrane overlap the top flange of the starter track.
8. Installed materials shall be checked before continuing system application.

C. Insulation Board:

1. Vertical surfaces: Begin at base of wall with firm, temporary support or spacer.
2. Stagger joints horizontally in a running bond pattern offset a minimum of 6".
3. Pre-cut insulation board to fit openings and projections. Insulation board must be a single piece around corners of openings. Stagger vertical joints and corners. Stagger insulation and sheathing board joints. Offset insulation board joints from sheathing joints by a minimum of 16".
4. Apply mixed base coat to entire surface of insulation board using a stainless-steel trowel with 1/2"x 1/2" (13 mm x 13 mm) notches spaced 2" (50 mm) apart. Ribbons of adhesive must be applied parallel to the 2' dimension of the EPS insulation board to ensure they are vertical when the EPS insulation board is applied to the substrate.
5. Immediately set board into place and apply pressure over entire surface of board to ensure positive uniform contact and high initial grab. Do not slide board into place. Do not allow base coat to dry prior to installing.
6. Abut all joints tightly and ensure overall flush level surface.
7. Fill 1/16" (1.6 mm) and larger gaps between insulation boards with slivers of insulation board.
8. Check adhesion periodically by removing a board prior to set. Properly installed insulation board will be difficult to remove, and adhesive/base coat will be adhered to both the air/water-resistive barrier and the insulation board.
9. Allow application of insulation board to dry (normally 8 to 10 hours) prior to application of base coat/reinforcing mesh.
10. Rasp flush any irregularities of the insulation board greater than 1/16" (1.6 mm).
11. Install expansion joints and aesthetic grooves as indicated on drawings. Do not align aesthetic grooves with insulation board joints.

D. Base Coat/Reinforcing Mesh:

1. Base coat shall be applied to achieve reinforcing mesh embedment with no reinforcing mesh color visible.

E. Corner Mesh:

1. Install at corners, prior to application of reinforcing mesh.
2. Apply mixed base coat to insulation board at outside corners using a stainless-steel trowel. Immediately place mesh against the wet base coat and embed into the base coat by troweling from the corner; butt edges and avoid wrinkles.
3. After base coat is dry and hard, apply a layer of reinforcing mesh over the entire surface of the corner mesh.

- F. Medium Impact to Intermediate Impact Resistance Reinforcing Mesh:
 - 1. Install reinforcing mesh where indicated on drawings.
 - 2. Apply mixed base coat to entire surface of insulation board with a stainless-steel trowel to embed the reinforcing mesh.
 - 3. Immediately place reinforcing mesh against wet base coat and embed the reinforcing mesh into the base coat by troweling from the center to the edges.
 - 4. Lap reinforcing mesh 2 ½" (64 mm) minimum at edges.
 - 5. Ensure reinforcing mesh is continuous at corners, void of wrinkles and embedded in base coat so that no reinforcing mesh color is visible.
 - 6. If required, apply a second layer of base coat to achieve total nominal base coat/reinforcing mesh thickness of 1/16" (1.6 mm).
 - 7. Allow base coat with embedded reinforcing mesh to dry hard (normally 8 to 10 hours).

- G. Color Coat:
 - 1. Apply material to the base coat/reinforcing mesh in sealant joints with a high-quality, latex-type paintbrush. Work material continuously until a uniform appearance is obtained.
 - 2. Allow to dry thoroughly (approximately 24 hours) prior to application of sealant primer and sealant.

- I. Tinted Primer:
 - 1. Apply Primer to the base coat/reinforcing mesh with a sprayer, ¾" (10 mm) nap roller, or good quality latex paint brush at a rate of approximately 150-250 ft² per gallon (3.6–6.1m² per liter).
 - 2. Primer shall be dry to the touch before proceeding to the finish coat application.

- J. Finish Coat:
 - 1. Apply finish directly to the base coat with a clean, stainless steel trowel.
 - 2. Apply and level finish during the same operation to minimum obtainable thickness consistent with uniform coverage.
 - 3. Maintain a wet edge on finish by applying and texturing continually over the wall surface.
 - 4. Work finish to corners, joints or other natural breaks and do not allow material to set up within an uninterrupted wall area.
 - 5. Float finish to achieve final texture.

- 3.4 CLEANING
 - A. Clean work under provisions of Section [01 74 00]
 - B. Clean adjacent surfaces and remove excess material, droppings, and debris.

- 3.5 PROTECTION
 - A. Protect materials from rain, snow and frost for 48–72 hours following application.
 - B. Protect installed construction under provisions of Section [01 76 00]

END OF SECTION 072400

SECTION 072500 – WEATHER BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wrap.
 - 2. Flexible flashing.
 - 3. Drainage material.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.
- B. Shop Drawings: Show details of building wrap at terminations, openings, and penetrations. Show details of flexible flashing applications.

PART 2 - PRODUCTS

2.1 WATER-RESISTIVE BARRIER

- A. Building Wrap: ASTM E 1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Dorken Systems Inc.](#)
 - b. [Dow Chemical Company \(The\).](#)
 - c. [DuPont Protection Solutions: E. I. du Pont de Nemours and Company.](#)
 - d. [Kingspan Insulation Limited.](#)
 - e. [Ludlow Coated Products.](#)
 - 2. Water-Vapor Permeance: Not less than 20 perms per ASTM E 96/E 96M, Desiccant Method (Procedure A).
 - 3. Air Permeance: Not more than 0.004 cfm/sq. ft. at 0.3-inch wg when tested according to ASTM E 2178.
 - 4. Allowable UV Exposure Time: Not less than three months.
 - 5. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.2 FLEXIBLE FLASHING

- A. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.030 inch.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [DuPont Protection Solutions: E. I. du Pont de Nemours and Company.](#)

- b. [GCP Applied Technologies Inc. \(formerly Grace Construction Products\).](#)
 - c. [Protecto Wrap Company.](#)
 - d. [Raven Industries, Inc.](#)
2. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- B. Primer for Flexible Flashing: Product recommended in writing by flexible flashing manufacturer for substrate.
- C. Nails and Staples: Product recommended in writing by flexible flashing manufacturer and complying with ASTM F 1667.

PART 3 - EXECUTION

3.1 WATER-RESISTIVE BARRIER INSTALLATION

- A. Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.
- B. Cover sheathing with water-resistive barrier as follows:
 - 1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
 - 2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap unless otherwise indicated.
- C. Building Wrap: Comply with manufacturer's written instructions and warranty requirements.
 - 1. Seal seams, edges, fasteners, and penetrations with tape.
 - 2. Extend into jambs of openings and seal corners with tape.

3.2 FLEXIBLE FLASHING INSTALLATION

- A. Apply flexible flashing to comply with manufacturer's written instructions.
 - 1. Prime substrates as recommended by flashing manufacturer.
 - 2. Lap seams and junctures with other materials at least 4 inches except that at flashing flanges of other construction, laps need not exceed flange width.
 - 3. Lap flashing over water-resistive barrier at bottom and sides of openings.
 - 4. Lap water-resistive barrier over flashing at heads of openings.
 - 5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

END OF SECTION 072500

SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes standing-seam metal roof panels.
- B. Related Sections:
 - 1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
 - 2. Section 133419 "Metal Building Systems" for Metal building construction and assembly.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review structural loading limitations of deck during and after roofing.
 - 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
 - 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 8. Review temporary protection requirements for metal panel systems during and after installation.
 - 9. Review procedures for repair of metal panels damaged after installation.
 - 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period with no dollar limit and no prorating.
 - 1. Warranty Period: 20 years from date of Substantial Completion.
 - 2. Peak gusts: 80 mph.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roof panels according to one of the following when tested according to ANSI/CRRC-S100:
 - 1. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E 1980.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 1. Wind Loads: As indicated on Drawing [S-003](#).
 - 2. Other Design Loads: As indicated on Drawing [S-003](#).
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
 - 1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [AEP Span; A BlueScope Steel Company](#).
 - b. [Architectural Building Components](#).

- c. [Berridge Manufacturing Company.](#)
 - d. [Centurion Industries, A-Lert Roof System](#)
 - e. [MBCI; a division of NCI Group, Inc.](#)
2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
- a. Nominal Thickness: 24 gauge.
 - b. Exterior Finish: Three-coat fluoropolymer.
 - c. Color: Burnished Slate to match existing.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature, Ice and Water Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 3. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Carlisle Residential; a division of Carlisle Construction Materials](#)
 - b. [Drexel Metals.](#)
 - c. [GCP Applied Technologies Inc. \(formerly Grace Construction Products\).](#)
 - d. [Henry Company](#)
 - e. [Kirsch Building Products, LLC.](#)
 - f. [Owens Corning.](#)

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.
- E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

- F. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.5 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
 2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
 1. Apply over the entire roof surface.
 2. Apply over the roof area indicated below:
 - a. Roof perimeter for a distance up from eaves of 36 inches beyond interior wall line.
 - b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.
 - c. Rake edges for a distance of 18 inches.
 - d. Hips and ridges for a distance on each side of 18 inches.
 - e. Roof-to-wall intersections for a distance from wall of 18 inches.
 - f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches.
- B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 1. Shim or otherwise plumb substrates receiving metal panels.
 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.

3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal panel work proceeds.
 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 4. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Clipless Metal Panel Installation: Fasten metal panels to supports with screw fasteners at each lapped joint at location and spacing recommended by manufacturer.
- G. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- H. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- I. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

- J. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
 - 1. Provide elbows at base of downspouts to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.

- K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16

SECTION 074293 - SOFFIT PANELS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes metal soffit panels.

B. Related Sections:

1. Section 076200 "Sheet Metal Flashing and Trim"
2. Section 074113.16 "Standing Seam Metal Roof Panels"
3. Section 133419 "Metal Building Systems"

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: Minimum 25 years from date of Substantial Completion.
- C. Special Warranty: Installer's standard form in which installer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - c. Structural failures including rupturing, cracking, or puncturing.
 - d. Deterioration of metals and other materials beyond normal weathering.
 - e. Watertightness
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 1. Wind Loads: As indicated on Drawing S-001.
 - 2. Other Design Loads: As indicated on Drawing S-001.
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Air Infiltration: Air leakage of not more than 1.55 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 1.57 lbf/sq. ft..

- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 2.86 lbf/sq. ft..
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL SOFFIT PANELS

- A. General: Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Architectural Building Components.
 - b. Berridge Manufacturing Company.
 - c. MBCI; a division of NCI Group, Inc.
 - d. McElroy Metal, Inc.
 - e. Ultra Seam Incorporated.
 - 2. Material: Same material, finish, and color as metal roof panels.
 - 3. Panel Coverage: 4 inches.
 - 4. Panel Height: 0.5 inches.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - 1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
 - 2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
 - a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
 - 1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Shim or otherwise plumb substrates receiving metal panels.
 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal panel work proceeds.
 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
1. Apply panels and associated items true to line for neat and weathertight enclosure.
 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
- E. Watertight Installation:
1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074293

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Manufactured through-wall flashing with snaplock receiver with counterflashing.
 - 2. Formed roof-drainage sheet metal fabrications.
 - 3. Formed sheet metal fabrications.
 - 4. Formed equipment support flashing.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
 - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
 - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
 - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 6. Include details of termination points and assemblies.
 - 7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 - 8. Include details of roof-penetration flashing.
 - 9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 - 10. Include details of special conditions.
 - 11. Include details of connections to adjoining work.
 - 12. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
 - 1. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Dark bronze.
 - 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature, Ice and Water Shield: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Carlisle Coatings & Waterproofing Inc.](#)
- b. [Carlisle Residential; a division of Carlisle Construction Materials.](#)
- c. [Drexel Metals.](#)
- d. [GCP Applied Technologies Inc. \(formerly Grace Construction Products\).](#)
- e. [Henry Company.](#)
- f. [Kirsch Building Products, LLC.](#)
- g. [Owens Corning.](#)
- h. [Polyguard Products, Inc.](#)
- i. [Protecto Wrap Company.](#)
- j. [SDP Advanced Polymer Products Inc.](#)

2. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.

3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- G. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.
- H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
1. Gutter Profile: Style A according to cited sheet metal standard.
 2. Expansion Joints: Lap type.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.
- C. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
1. Aluminum: 0.040 inch thick.

2.7 SHEET METAL FABRICATIONS

- A. Roof-to-Wall Transition Expansion-Joint Cover: Fabricate from the following materials:
1. Aluminum: 0.050 inch thick.
- B. Base Flashing: Fabricate from the following materials:
1. Aluminum: 0.040 inch thick.
- C. Counterflashing: Fabricate from the following materials:
1. Aluminum: 0.032 inch thick.
- D. Flashing Receivers: Fabricate from the following materials:
1. Aluminum: 0.032 inch thick.
- E. Roof-Penetration Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 - 5. Torch cutting of sheet metal flashing and trim is not permitted.
 - 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

- F. Seal joints as required for watertight construction.
 - 1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
 - 1. Fasten gutter spacers to front and back of gutter.
 - 2. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
 - 3. Anchor gutter with gutter brackets spaced not more than 24 inches apart to roof deck, unless otherwise indicated, and loosely lock to front gutter bead.
 - 4. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.
- C. Downspouts: Join sections with 1-1/2-inch telescoping joints.
 - 1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.
 - 2. Provide elbows at base of downspout to direct water away from building.
 - 3. Connect downspouts to underground drainage system.
- D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant compatible with the substrate.

3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of interlocking folded seam or blind rivets and sealant unless otherwise indicated.
- D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.7 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Prefformed flashing sleeves.
- B. Related Sections:
 - 1. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
 - 2. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.3 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 PREFORMED FLASHING SLEEVES

- A. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
 - 1. Metal: Same as roof..
 - 2. Height: 13 inches.
 - 3. Diameter: As indicated on Drawings.
 - 4. Finish: Same as roof.

2.3 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Preformed Flashing-Sleeve and Flashing Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078400 – FIRESTOPPING

PART 1.0 – GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. All referenced publications shall be the most current edition in effect on the date of solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	Surface Burning Characteristics of Building Materials
ASTM E 119	Fire Tests of Building construction and Materials
ASTM E 814	Fire Tests of Through-Penetration Fire Stops

UNDERWRITERS LABORATORIES (UL)

UL 723	Test for Surface Burning Characteristics of Building Materials
UL 1479	Fire Tests of through-Penetration Firestops
UL 2079	Tests for Fire Resistance of Building Joint Systems
UL	Fire Resistance Directory

1.2 SUBMITTALS

A. The following shall be submitted for approval or for information only as indicated on AF Form 66, utilizing AF Form 3000 in accordance with Section 01010, SUBMITTALS:

1. Drawings consisting of manufacturer’s descriptive data, typical details, installation instructions and the fire-test data and/or report as appropriate for the fire resistance rated construction and location. Submittal shall indicate the firestopping material to be provided for each type of application. When more than 5 penetrations or construction joints are to receive firestopping, drawings shall indicate location and type of application.
2. Certificates attesting that firestopping material complies with the specified requirements. The label or listing of the Underwriters laboratories shall be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing agency equipped to perform such services, stating that the items have been tested and conform to the specified requirements and testing methods.
3. Documentation of training and Experience: Manufacturer’s representative certification stating that the firestopping work has been inspected and found to be applied according to the manufacturer’s recommendations and the specified requirements.

1.3 GENERAL REQUIREMENTS:

A. Firestopping shall consist of providing a material or a combination of materials to form an effective barrier against the spread of flame, smoke and gases and maintain the integrity of fire resistance rated walls, partitions, floors and ceiling-floor assemblies, including through-penetrations and construction joints. Through-penetrations include the annular space around pipes, tubes, conduits, wire, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind or seismic movement. Firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof deck.

1.4 STORAGE AND DELIVERY: Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

1.5 **INSTALLER QUALIFICATIONS:** Installer of firestopping material shall be trained by the manufacturer or the manufacturer's representative and shall have a history experience in the installation of firestopping of the type specified.

PART 2.0 – PRODUCTS

2.1 FIRESTOPPING MATERIALS

2.1.1 Firestopping Materials shall consist of commercially manufactured products complying with the following minimum requirements: shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84 or UL 723. materials shall be an approved firestopping material as listed in the UL Fire Resistance Directory or by a nationally recognized testing laboratory. Materials shall be nontoxic to humans at all stages of applications. Firestopping shall not be required to have a greater fire resistance rating than that of the assembly in which it is being placed. Firestopping materials for through-penetrations shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479, except that "T" ratings are not required for penetrations smaller than or equal to a 4 inch nominal pipe or 16 square inches in overall cross sectional area.

2.1.2 Fire resistance ratings shall be the following:

2.1.3 Penetrations of fire resistance rated walls and partitions: "F" rating = 1 hour, "T" rating = 1 ½ hour.

2.1.4 Penetrations of fire resistance rated floors and ceiling-floor assemblies: "F" rating = 1 hour, "T" rating = 1 ½ hour.

2.1.5 Fire resistance ratings of construction joints and gaps such as those between floor slabs or roof decks and curtain walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119 or UL 2079 to meet the required fire resistance rating.

PART 3.0 – EXECUTION

3.1 **PREPARATION:** Areas to receive firestopping shall be free of dirt, grease, oil or loose materials that may affect the fitting or fire resistance of the firestopping system.

3.2 **INSTALLATION:** Firestopping materials shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be provided in accordance with the manufacturer's written instructions. Firestopping shall be provided in the following locations, except in floor slabs on grade:

3.2.1 Penetrations of ducts, conduits, tubing, cable and pipe through floors and through fire-resistant rated walls, partitions and ceiling-floor assemblies.

3.2.2 Penetrations of vertical shafts such as pipe chases, elevator shafts and utility chutes.

3.2.3 Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

3.2.4 Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

3.2.5 Construction joints in floors and fire rated walls and partitions.

3.2.6 Other locations where required to maintain fire resistance rating of the construction.

END OF SECTION 078400

SECTION 079200 – JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Nonstaining silicone joint sealants.
 - 3. Urethane joint sealants.
 - 4. Immersible joint sealants.
 - 5. Silyl-terminated polyether joint sealants.
 - 6. Mildew-resistant joint sealants.
 - 7. Polysulfide joint sealants.
 - 8. Butyl joint sealants.
 - 9. Latex joint sealants.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
- C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - 1. Joint-sealant location and designation.
 - 2. Manufacturer and product name.
 - 3. Type of substrate material.
 - 4. Proposed test.
 - 5. Number of samples required.
- D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are

needed for adhesion.

- E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion-Test Reports: For each sealant application tested.
- G. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 - 3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with masonry, concrete substrates.
 - 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
 - 5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
 - 7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Conduct field tests for each kind of sealant and joint substrate.
 - 2. Notify Architect seven days in advance of dates and times when test joints will be erected.
 - 3. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 - 4. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. **VOC Content:** Sealants and sealant primers shall comply with the following:
 - 1. Architectural sealants shall have a VOC content of 250 g/L or less.
 - 2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
 - 3. Sealants and sealant primers for porous substrates shall have a VOC content of 775 g/L or less.
- C. Colors of Exposed Joint Sealants: Match Architect's samples.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Adfast.](#)
 - b. [Dow Corning Corporation.](#)
 - c. [GE Construction Sealants; Momentive Performance Materials Inc.](#)
 - d. [May National Associates, Inc.; a subsidiary of Sika Corporation.](#)
 - e. [Pecora Corporation.](#)
 - f. [Sika Corporation; Joint Sealants.](#)

2.3 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.

2.4 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [BASF Corp. - Construction Chemicals.](#)
 - b. [ER Systems; an ITW Company.](#)
 - c. [Pecora Corporation.](#)
 - d. [Sherwin-Williams Company \(The\).](#)
 - e. [Sika Corporation; Joint Sealants.](#)

- B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement

capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BASF Corp. - Construction Chemicals.
 - b. Pecora Corporation.
 - c. Polymeric Systems, Inc.
 - d. Schnee-Morehead, Inc., an ITW company.
 - e. Sherwin-Williams Company (The).

- C. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Tremco Incorporated.

- D. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. LymTal International Inc.

2.5 SILYL-TERMINATED POLYETHER (STPE) JOINT SEALANTS

- A. STPE, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corp. - Construction Chemicals.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. Pecora Corporation.
 - d. Sherwin-Williams Company (The).
 - e. Sika Corporation; Joint Sealants.

2.6 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Adfast.
- b. Dow Corning Corporation.
- c. GE Construction Sealants; Momentive Performance Materials Inc.
- d. May National Associates, Inc.; a subsidiary of Sika Corporation.
- e. Pecora Corporation.
- f. Soudal USA.
- g. Tremco Incorporated.

2.7 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Everkem Diversified Products, Inc.
 - b. Franklin International.
 - c. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - d. Pecora Corporation.
 - e. Sherwin-Williams Company (The).
 - f. Tremco Incorporated.

2.8 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Adfast.
 - b. Alcot Plastics Ltd.
 - c. BASF Corp. - Construction Chemicals.
 - d. Construction Foam Products; a division of Nomaco, Inc.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

Nonporous joint substrates include the following:

- a. Metal.
- b. Glass.
- c. Porcelain enamel.
- d. Glazed surfaces of ceramic tile.

- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
 4. Provide recessed joint configuration of recess depth and at according to Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab,

in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

- a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Tile control and expansion joints.
 - c. Joints between different materials listed above.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, M, P, 50, T, NT.
 3. Joint-Sealant Color: Match adjacent material color.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between plant-precast architectural concrete units.
 - c. Control and expansion joints in unit masonry.
 - d. Joints between metal panels.
 - e. Joints between different materials listed above.
 - f. Perimeter joints between materials listed above and frames of doors and.
 - g. Control and expansion joints in ceilings and other overhead surfaces.
 2. Joint Sealant: Urethane, NS, 50, NT.
 3. Joint-Sealant Color: Match adjacent material color.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:

- a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated on Drawings.
2. Joint Sealant: Urethane, S, P, 25, T, NT.
 3. Joint-Sealant Color: Match adjacent material color.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry, concrete, walls, and partitions.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, NS, 25, NT.
 3. Joint-Sealant Color: Match adjacent material color.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors and elevator entrances.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: STPE, S, NS, SO, NT.
 3. Joint-Sealant Color: Grey.

END OF SECTION 079200

SECTION 081113 – STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Standard steel frames. Interior and Exterior
 - 2. Standard steel doors. Interior and Exterior

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each frame type.
 - 2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 3. Locations of reinforcement and preparations for hardware.
 - 4. Details of each different wall opening condition.
 - 5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors, hollow metal frames, and accessories undamaged palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.
- D. Remove damp or wet packaging immediately and wipe affected surfaces dry.
- E. Replace damaged material with new.

PART 2 - PRODUCTS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Baron Metal Industries Inc.: an Assa Abloy Group company.](#)
 2. [Black Mountain Door, LLC.](#)
 3. [Concept Frames, Inc.](#)
 4. [Custom Metal Products.](#)
 5. [Deansteel Manufacturing Company, Inc.](#)

2.1 STANDARD STEEL DOORS

2.1.1 FIRE DOORS and FRAMES

- A. Provide fire doors and frames in accordance with NFPA 80 and this specification.
- B. Construct doors to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- C. Frames: SDI A250.8. At locations indicated in the Door and Frame Schedule.
1. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
 2. Construction: Full profile welded.
 3. Exposed Finish: Prime.
- D. Labels: Provide fire doors and frames bearing the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International attesting to the rating required. Testing must be in accordance with NFPA 252 or UL 10C. Provide labels that are metal with raised letters, bearing the file name or file number of the door and frame manufacturer. Labels must be permanently affixed at the factory to the frames and the hinge edge of the door. Do not paint door and labels.

2.2 FRAME ANCHORS

- E. Jamb Anchors:
1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- F. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- G. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- H. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.3 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated,

fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

2.4 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

2.5 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with SDI A250.11.
- B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - 1. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - 2. Install frames with removable stops located on secure side of opening.
- C. Floor Anchors: Secure with postinstalled expansion anchors.
 - 1. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- D. Solidly pack mineral-fiber insulation inside frames.
- E. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and

- perpendicular to plane of wall.
- 4. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

F. Fire Doors and Frames: Install fire doors and frames, including hardware, in accordance with NFPA 80.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Interior standard steel frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each frame type.
 - 2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 3. Locations of reinforcement and preparations for hardware.
 - 4. Details of each different wall opening condition.
 - 5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Baron Metal Industries Inc.: an Assa Abloy Group company.](#)
 2. [Black Mountain Door, LLC.](#)
 3. [Concept Frames, Inc.](#)
 4. [Custom Metal Products.](#)
 5. [Deansteel Manufacturing Company, Inc.](#)

2.2 STANDARD STEEL FRAMES

- A. Construct hollow-metal frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Interior Frames: SDI A250.8. At locations indicated in the Door and Frame Schedule.
1. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
 2. Construction: Full profile welded.
 3. Exposed Finish: Prime.

2.3 FRAME ANCHORS

- A. Jamb Anchors:
1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.4 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Glazing: Comply with requirements in Section 088000 "Glazing."

2.5 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

2.6 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with SDI A250.11.
- B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - 1. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - 2. Install frames with removable stops located on secure side of opening.
- C. Floor Anchors: Secure with postinstalled expansion anchors.
 - 1. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- D. Solidly pack mineral-fiber insulation inside frames.
- E. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081416 - FLUSH WOOD DOORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory finished and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.
- C. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.
- B. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 43 and 70 percent during remainder of construction period.

1.6 WARRANTY

- A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [ABS- American Building Supply- Doormerica.](#)
 2. [Chappell Door Co.](#)
 3. [General Veneer Manufacturing Co.](#)
 4. [Haley Brothers, Inc.](#)
 5. [Lambton Doors.](#)
 6. [Masonite Architectural Doors](#)
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards and WDMA I.S.1-A, "Architectural Wood Flush Doors."
 1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
 2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. WDMA I.S.1-A Performance Grade: Heavy Duty.
- C. WDMA I.S.1-A Performance Grade:
 1. Heavy Duty unless otherwise indicated.
- D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- E. Particleboard-Core Doors:
 1. Particleboard: ANSI A208.1, Grade LD-1 or Grade LD-2.
 2. Blocking: Provide wood blocking in particleboard-core doors as follows:
 - a. 5-inch top-rail blocking, in doors indicated to have closers.
 - b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - c. 5-inch midrail blocking, in doors indicated to have exit devices.
 - d.
 3. Provide doors with glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:
 1. Grade: Premium, with Grade A faces.
 2. Species: Select white birch.
 3. Cut: Plain sliced (flat sliced).
 4. Match between Veneer Leaves: Book match.
 5. Assembly of Veneer Leaves on Door Faces: Balance match.
 6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.

8. Exposed Vertical and Top Edges: Same species as faces - edge Type A.
9. Core: Particleboard.
10. Construction: plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.
11. Construction: Seven plies, either bonded or nonbonded construction.
12. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.5 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Factory finish doors that are indicated to receive transparent finish.
- D. Factory finish doors where indicated in schedules or on Drawings as factory finished.
- E. Transparent Finish:
 1. Grade: Premium.
 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 5, conversion varnish or System 9, UV curable, acrylated epoxy, polyester, or urethane.
 3. Staining: Match Architect's laminate sample: Wilsonart MORRIS OAK 17005K-57.
 4. Effect: Filled finish.
 5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
 - B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
 - 2. Install smoke- and draft-control doors according to NFPA 105.
 - C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - a. Comply with NFPA 80 for fire-rated doors.
 - b. 2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 - D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
 - E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- 3.3 ADJUSTING
- A. Operation: Rehang or replace doors that do not swing or operate freely.
 - B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Acudor Products, Inc.](#)
 - b. [Babcock-Davis.](#)
 - c. [Cendrex Inc.](#)
 - d. [Elmdor/Stoneman Manufacturing Company; a division of Acorn Engineering Company.](#)
 - e. [JL Industries, Inc.; a division of the Activar Construction Products Group.](#)
 - 2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 3. Locations: Wall and ceiling.
 - 4. Door Size: 24 inches x 24 inches at ceilings. 12 inches x 12 inches at walls.
 - 5. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
 - 6. Frame Material: Same material, thickness, and finish as door.
 - 7. Latch and Lock: Cam latch, screwdriver operated.

2.2 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Frame Anchors: Same material as door face.
- D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior storefront framing.
 - 2. Interior manual-swing entrance doors and door-frame units.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware".
 - 2. Section 088000 "Glazing."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1.3 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Company, Inc., series Trifab 451 for interior locations (non-ATFP) or comparable product by one of the following:
 - 1. EFCO Corporation.
 - 2. Pittco Architectural Metals, Inc.
 - 3. United States Aluminum.

2.2 FRAMING

- A. Framing Members: Manufacturer's extruded- framing members of thickness required.
 - 1. Construction: Nonthermal.
 - 2. Glazing System: Manufacturer's recommended system.
 - 3. Glazing Plane: Center.
 - 4. Finish: Dark Bronze anodic finish.
 - 5. Fabrication Method: Field-fabricated stick system.
 - 6. Frame dimensions: as indicated on drawings.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.

2.3 INTERIOR ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
 - 1. Heavy Duty Door Construction: 2 1/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - 2. Door Design: Reference drawings Door Elevations.
 - 3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.

2.4 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

2.5 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing" for interior glazing.
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.6 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
- E. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: Black

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure non-movement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Section 088000 "Glazing."
- F. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
 - 1. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

END OF SECTION 084113

SECTION 087100 – DOOR HARDWARE

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 commercial door hardware for the following:
 - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
 - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series
 - 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware. **Coordinate schedule with hardware schedule indicated on drawings.**
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.

- g. Door and frame sizes and materials.
 - h. Warranty information for each product.
4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- D. Informational Submittals:
- 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
- E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
- 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss preparatory work performed by other trades.
3. Review and finalize construction schedule and verify availability of materials.
4. Review the required inspecting, testing, commissioning, and demonstration procedures

- H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
1. Structural failures including excessive deflection, cracking, or breakage.
 2. Faulty operation of the hardware.
 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
1. Ten years for mortise locks and latches.
 2. Five years for exit hardware.
 3. Twenty five years for manual surface door closer bodies.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 - 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 - 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 - 5. Manufacturers:
 - a. Ives (IV).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Stanley Hardware (ST).

- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
 - 1. Manufacturers:
 - a. Ives (IV).
 - b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - c. Stanley Hardware (ST).

2.3 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
 - 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 - 2. Furnish dust proof strikes for bottom bolts.
 - 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 - 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 - 5. Manufacturers:
 - a. Ives (IV).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TR).
- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
 - 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 - 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 - 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 - 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - 5. Manufacturers:
 - a. Ives (IV).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TR).

2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
 - 1. Manufacturers:
 - a. Best (BE).
 - b. No Substitution.
- C. Cylinders: Original manufacturer cylinders complying with the following:
 - 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 - 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 - 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 5. Keyway: Match Facility Restricted Patented Keyway.
- D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware. Provide removable core (small or large format) as specified in Hardware Sets.

- E. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. Existing System: Key locks to Owner's existing system.

- F. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Two (2)
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
 - 4. Construction Control Keys (where required): Two (2).
 - 5. Permanent Control Keys (where required): Two (2).

- G. Construction Keying: Provide temporary keyed construction cores for all locks and cylinders.

- H. Key Registration List (Bitting List):
 - 1. Provide transcript list in writing or electronic file as directed by the Owner.

- I. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
 - 1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 - 1. Manufacturers:
 - a. Best (BE) – 40H-UN Series (unless noted otherwise)

2.6 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 - 4. Dustproof Strikes: BHMA A156.16.

2.7 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
 - 1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
 - 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 - 3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the push bar

- and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Von Duprin (VD) - 99 Series.
 - b. Sargent (SA) – 80 Series.
 - c. Precision (PR) – Apex 2000 Series.

2.8 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one-piece cast-iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Manufacturers:
 - a. LCN Closers (LC) - 4040XP Series.
 - b. Norton Door Controls (NO) – 9500 Series.
 - c. Sargent Manufacturing (SA) - 281 Series.

2.9 ARCHITECTURAL TRIM

- A. Door Protective Trim
1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Ives (IV).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.10 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Manufacturers:
 - a. Ives (IV).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
 1. Manufacturers:
 - a. Architectural Builders Hardware (AH).
 - b. Glynn Johnson (GJ).
 - c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.11 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Zero (ZE).

2.12 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.13 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Finish shall be US26D unless otherwise noted. Refer to Door Hardware Schedule drawing sheet no.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are

later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 HARDWARE SCHEDULE

HARDWARE SCHEDULE					
QTY.	NAME	MFR.	MODEL	FINISH	NOTES
TYPE 1: DOORS 142					
DESCRIPTION: PAIR EXT. MECH. ROOM DOORS					
6	HINGES	STANLEY	CEFBB179 4-1/2" X 4-1/2"	US10B	DARK BRONZE FINISH
2	FLUSH BOLT	ROCKWOOD	555	US26D	SATIN CHROME PLATED FINISH
1	DUST PROOF STRIKE	ROCKWOOD	570	US26D	SATIN CHROME PLATED FINISH
1	STOREROOM LOCK	BEST ACCESS SYS.	45H7D-3J	626	SATIN CHROME FINISH
2	DOOR CLOSER	SARGENT	281 -P10	EB	DARK OXIDIZED SATIN BRONZE
2	KICK PLATES	ROCKWOOD	K1050-CSK	US32	10"x 34", POLISHED STAINLESS STEEL FINISH
2	DOOR STOP	ROCKWOOD	461L	US26D	SATIN CHROME PLATED FINISH
6	SILENCER	ROCKWOOD	-	-	-
NOTE: TEMPLATE CLOSERS FOR 180-DEGREE SWING					
TYPE 2: DOORS 147A					
DESCRIPTION: PAIR EXT. STOREFRONT ENTRY DOORS					
2	CONTINUOUS HINGES	PEMKO	DFM HD1 SLF OR SLF AS REQD	BSP	BLACK SUEDE POWDER COAT
1	CONC. VERT. ROD EXIT	VON DUPRIN	9849-NL-OP 110MD	622/711	MATTE BLACK, ANODIZED
1	CONC. VERT. ROD EXIT	VON DUPRIN	9849-EO	622/711	MATTE BLACK, ANODIZED
1	CYLINDER	BEST ACCESS SYS.	1E-74-C4-RP3	626	SATIN CHROME FINISH
2	PULL	ROCKWOOD	BF-162	US26D	SATIN CHROME PLATED BRASS FINISH

2	CONC. OVERHEAD STOP	RIXSON	1-336	BSP	BLACK SUEDE POWDER COAT
2	DOOR CLOSER	SARGENT	281 -P10	BSP	BLACK SUEDE POWDER COAT
1	THRESHOLD	PEMKO	2005AT	AT	MILL FINISH ALUMINUM
2	SWEEP	PEMKO	315DN	315DN	DK BRONZE ANODIZED ALUMINUM

NOTE: PERIMETER SEAL AND ASTRAGAL BY DOOR SUPPLIER

TYPE 3: DOORS 147B, 148

DESCRIPTION: SINGLE EXT. STOREFRONT ENTRY DOORS

1	CONTINUOUS HINGE	PEMKO	DFM HD1 SLF OR SLF AS REQ'D	BSP	BLACK SUEDE POWDER COAT
1	CONC. VERT. ROD EXIT	VON DUPRIN	9849-NL-OP 110MD	622/711	MATTE BLACK, ANODIZED
1	CYLINDER	BEST ACCESS SYS.	1E-74-C4-RP3	626	SATIN CHROME FINISH
1	PULL	ROCKWOOD	BF-162	US26D	SATIN CHROME PLATED BRASS FINISH
1	CONC. OVERHEAD STOP	RIXSON	1-336	BSP	BLACK SUEDE POWDER COAT
1	DOOR CLOSER	SARGENT	281 -P10	BSP	BLACK SUEDE POWDER COAT
1	THRESHOLD	PEMKO	2005AT	AT	MILL FINISH ALUMINUM
1	SWEEP	PEMKO	315DN	315DN	DK BRONZE ANODIZED ALUMINUM

NOTE: PERIMETER SEAL AND ASTRAGAL BY DOOR

SUPPLIER TYPE 4: DOORS 143, 158 (BID

OPTION: 130) DESCRIPTION: SINGLE RESTROOM DOORS

3	HINGES	STANLEY	CEFBB179 4-1/2" X 4-1/2"	US15	SATIN NICKEL
1	PULL PLATE	ROCKWOOD	102X70B	US32	3.5"X15", POLISHED STAINLESS STEEL FINISH
1	DOOR CLOSER	SARGENT	281-P10	15	SATIN NICKEL
1	KICK PLATE	ROCKWOOD	K1050-CSK	US32	10"x 34", POLISHED STAINLESS STEEL FINISH
1	PUSH PLATE	ROCKWOOD	71B	US32D	3.5"X15", SATIN STAINLESS STEEL
1	WALL STOP	ROCKWOOD	409	US32D	SATIN STAINLESS STEEL FINISH
3	SILENCER	ROCKWOOD	-	-	-

TYPE 5: DOORS 145,156

DESCRIPTION: TELECOMMUNICATIONS AND JANITOR'S CLOSET

3	HINGES	STANLEY	CEFBB179 4-1/2" X 4-1/2"	US15	SATIN NICKEL
1	STOREROOM LOCK	BEST ACCESS SYS.		626	SATIN CHROME FINISH
1	DOOR CLOSER	SARGENT		15	SATIN NICKEL
1	KICK PLATE	ROCKWOOD		US32	10"x 34", POLISHED STAINLESS STEEL FINISH
1	WALL STOP	ROCKWOOD	409	US32D	SATIN STAINLESS STEEL FINISH
3	SILENCER	ROCKWOOD	-	-	-

TYPE 6: DOORS 146,149,150,151,152,153,154,155,156 (BID OPTIONS: 129-1,129-2,131-1,131-2,133,13

DESCRIPTION: BEDROOM ENTRY

3	HINGES	STANLEY	CEFBB179 4-1/2" X 4-1/2"	US15	SATIN NICKEL
1	DORMITORY LOCK	BEST ACCESS SYS.	45H7T-3J-S6	626	SATIN CHROME FINISH, LATCH/DEADBOLT STRIKE
1	DOOR CLOSER	SARGENT	281-P10	15	SATIN NICKEL
1	KICK PLATE	ROCKWOOD	K1050-CSK	US32	10"x 34", POLISHED STAINLESS STEEL FINISH
1	WALL STOP	ROCKWOOD	409	US32D	SATIN STAINLESS STEEL FINISH
3	SILENCER	ROCKWOOD	-	-	-

TYPE 7: DOORS 146A,146B,149A,149B,150A,150B,151A,151B,152A,152B,153A,153B,154A,154B,155A,155B (BID

OPTIONS: 129-1A,129-1B,129-2A,129-2B,131-1A,131-1B,131-2A,131-2B,133A,133B,134A,134B DESCRIPTION:

BEDROOM CLOSET

3	HINGES	STANLEY	CEFBB179 4-1/2" X 4-1/2"	US15	SATIN NICKEL
4	PASSAGE LOCK	BEST ACCESS SYS.	45H7T-3J-S6	626	SATIN CHROME FINISH
4	WALL STOP	ROCKWOOD	409	US32D	SATIN STAINLESS STEEL FINISH
3	SILENCER	ROCKWOOD	-	-	-

DOOR SCHEDULE NOTES

H.M. = HOLLOW METAL

1. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS AND UNIFIED FACILITIES GUIDE SPECIFICATIONS.
2. VERIFY EXISTING OPENINGS AND ADJUST TO MEET ADA AND ANSI 117.1 STANDARDS.
3. INSTALL NEW THRESHOLD PLATES ON ALL NEW INSTALLATIONS.
4. NEW DOOR, CLOSURE, AND DOOR LOCK HARDWARE PER ADA AND ANSI 117.1 STANDARDS.
5. WEATHER SEAL ALL CONNECTION POINTS.
6. LOCKSETS SHALL BE COMPATIBLE WITH THE EXISTING BASE SCHLAGE MASTER KEYWAY SYSTEM.
7. LOCKSETS SHALL HAVE BEST LOCK CORES.
8. USE STAINLESS STEEL FASTENERS THROUGHOUT.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Glass for interior doors and storefront system.
 - 2. Glazing sealants and accessories.
- B. Related Requirements:
 - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts",

1.2 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
 - 2. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: "Glazing Manual."
- B. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- C. Strength: Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.
 - 3. Grid suspension systems for gypsum board ceilings.
- B. Related Requirements:
 - 1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C 645. Use either steel studs and tracks or embossed steel studs and tracks.
 - 1. Steel Studs and Tracks:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) CEMCO; California Expanded Metal Products Co.
 - 2) ClarkDietrich Building Systems.

- 3) [Custom Stud.](#)
 - 4) [Jaimes Industries.](#)
 - 5) [MarinoWARE.](#)
- b. Minimum Base-Metal Thickness: 33 mil.
 - c. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Provide the following:
1. Single Long-Leg Track System: ASTM C 645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 2. Double-Track System: ASTM C 645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - 1) [CEMCO; California Expanded Metal Products Co.](#)
 - 2) [ClarkDietrich Building Systems.](#)
 - 3) [MarinoWARE.](#)
 - 4) [MBA Building Supplies.](#)
 - 5) [Metal-Lite.](#)
- D. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [ClarkDietrich Building Systems.](#)
 - b. [MarinoWARE.](#)
 - c. [MRI Steel Framing, LLC.](#)
 - d. [SCAFCO Steel Stud Company.](#)
 - e. [Steel Construction Systems.](#)
 2. Depth: 1-1/2 inches.
 3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [ClarkDietrich Building Systems.](#)
 - b. [Jaimes Industries.](#)
 - c. [MarinoWARE.](#)
 - d. [MRI Steel Framing, LLC.](#)
 - e. [SCAFCO Steel Stud Company.](#)
 2. Minimum Base-Metal Thickness: 33 mil.
 3. Depth: As indicated on Drawings.
- 2.3 SUSPENSION SYSTEMS
- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
1. Depth: As indicated on Drawings.
- D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.

2. Steel Studs and Tracks: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 33 mil..
 - b. Depth: As indicated on Drawings.
 3. Embossed Steel Studs and Tracks: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 33 mil. .
 - b. Depth: As indicated on Drawings.
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Chicago Metallic Corporation.
 - c. USG Corporation.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 12 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM

BOARD PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
 - 3. Texture finishes.
- B. Related Requirements:
 - 1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
 - 2. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
 - 3. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C 1396/C 1396M.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following g:

- a. [American Gypsum.](#)
 - b. [CertainTeed Corporation.](#)
 - c. [Continental Building Products, LLC.](#)
 - d. [Georgia-Pacific Gypsum LLC.](#)
 - e. [USG Corporation.](#)
2. Thickness: 5/8 inch.
 3. Long Edges: Tapered.
- B. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [American Gypsum.](#)
 - b. [CertainTeed Corporation.](#)
 - c. [Continental Building Products, LLC.](#)
 - d. [Georgia-Pacific Gypsum LLC.](#)
 - e. [USG Corporation.](#)
 2. Thickness: 1/2 inch.
 3. Long Edges: Tapered.
- 2.3 TILE BACKING PANELS
- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.
1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [C-Cure.](#)
 - b. [CertainTeed Corporation.](#)
 - c. [Custom Building Products.](#)
 - d. [James Hardie Building Products, Inc.](#)
 - e. [USG Corporation.](#)
 2. Thickness: 5/8 inch.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- 2.4 TRIM ACCESSORIES
- A. Interior Trim: ASTM C 1047.
1. Material: Paper-faced galvanized-steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- 2.5 JOINT TREATMENT MATERIALS
- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
1. Interior Gypsum Board: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: Refer to Section 072100 Thermal Insulation.

E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Accumetric LLC.](#)
 - b. [Everkem Diversified Products, Inc.](#)
 - c. [Grabber Construction Products.](#)
 - d. [Hilti, Inc.](#)
 - e. [USG Corporation.](#)

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

2.7 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Non-Aggregate Finish: Premixed, vinyl texture finish for spray application.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [CertainTeed Corporation.](#)
 - b. [National Gypsum Company.](#)
 - c. [USG Corporation.](#)
2. Texture: Light orange peel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: As indicated on Drawings.
 - 2. Ceiling Type: As indicated on Drawings.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Where indicated on Drawings.
 - 3. Level 3: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
 - 5. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 APPLYING TEXTURE FINISHES

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
- B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture matching approved mockup and free of starved spots or other evidence of thin application or of application patterns.
- C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written instructions.

3.8 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Tile products.
 - 2. Tile backing panels.
 - 3. Waterproof and Crack Isolation membrane.
 - 4. Setting materials.
 - 5. Grout materials.
 - 6. Metal edge strips.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
 - 2. Section 092900 "Gypsum Board" for cementitious backer units.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Full-size units of each type of trim and accessory for each color and finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
 - 2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
 - 3. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.

- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

- A. Porcelain Tile Type "TL-1": Porcelain Floor Tile.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Olean; a division of Dal-Tile Corporation.
 - b. Crossville, Inc.
 - c. Daltile.
 - d. Interceramic.
 - 2. Composition: Porcelain.
 - 3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
 - 4. Module Size: 2 feet by 2 feet.
 - 5. Thickness: 13/32 inch.
 - 6. Face: Pattern of design indicated.
 - 7. Surface: Smooth, without abrasive admixture.
 - 8. Dynamic Coefficient of Friction: Not less than 0.42.
 - 9. Tile Color and Pattern: As indicated in drawings.
 - 10. Grout Color: As indicated in drawings.
 - 11. Trim Units: Metal trim pieces as indicated.
- B. Porcelain Tile Type "TL-2". Porcelain Wall Tile.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Olean; a division of Dal-Tile Corporation.
 - b. Crossville, Inc.
 - c. Daltile.
 - d. Florida Tile, Inc.
 - e. Interceramic.
 - 2. Certification: Tile certified by the Porcelain Tile Certification Agency.
 - 3. Face Size: 12 by 24 inches,
 - 4. Thickness: 3/8" inch.
 - 5. Face: As indicated on the drawings.
 - 6. Dynamic Coefficient of Friction: Not less than 0.42.
 - 7. Tile Color, Glaze, and Pattern: As indicated in drawings.
 - 8. Grout Color: As indicated in drawings.
 - 9. Trim Units: Metal trim pieces as indicated. Cove Base P-36C9T, Cove Base Outcorner PC-36C9T

2.4 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, Type A, in maximum lengths available to minimize end-to-end butt joints.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C-Cure.
 - b. Custom Building Products.
 - c. USG Corporation.
 - 2. Thickness: As indicated.

2.5 WATERPROOF & CRACK ISOLATION MEMBRANE

- A. General: May be a sheet or fluid applied product. Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer. The Contractor will be required to submit for approval on an

AF3000 the material it intends to use for each application.

- B. Sheet goods: System consisting of rubber, pvc, or plastic.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Boiardi Products Corporation](#)
 - b. [Compotite Corpaoration](#)
 - c. [National Applied Construction Products, Inc.](#)
 - d. [Noble Company \(The\).](#)
 - e. [Schulter Sysystems L.P](#)
- C. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Bostik, Inc.](#)
 - b. [Custom Building Products.](#)
 - c. [LATICRETE SUPERCAP, LLC.](#)
 - d. [MAPEI Corporation.](#)
- D. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ARDEX Americas.](#)
 - b. [Custom Building Products.](#)
 - c. [LATICRETE SUPERCAP, LLC.](#)
 - d. [MAPEI Corporation.](#)
- E. Latex-Portland Cement Waterproof Mortar: Flexible, waterproof mortar consisting of cement-based mix and latex additive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [C-Cure.](#)
 - c. [MAPEI Corporation.](#)
- F. Crack Isolation Membrane and Tile-Setting Adhesive: One-part, fluid-applied product intended for use as both a crack isolation membrane and tile-setting adhesive in a two-step process.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Boiardi Products Corporation; a QEP company.](#)
 - b. [Bostik, Inc.](#)
- G. Waterproofing and Tile-Setting Adhesive: One-part, fluid-applied product intended for use as both waterproofing and tile-setting adhesive in a two-step process.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Boiardi Products Corporation; a QEP company.](#)
 - b. [Bostik, Inc.](#)
- H. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction. Adhesives shall be applied as per manufacturers instructions and recommendations.

2.6 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
1. Cleavage Membrane: Asphalt felt, ASTM D 226/D 226M, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
 2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.
 3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
 - a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
 - b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
 - c. Configuration over Studs and Furring: Flat.
 - d. Configuration over Solid Surfaces: Self-furring.
 - e. Weight: 2.5 lb./sq. yd..

4. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Bostik, Inc.](#)
 - b. [C-Cure.](#)
 - c. [Custom Building Products.](#)
 - d. [LATICRETE SUPERCAP, LLC.](#)
 - e. [MAPEI Corporation.](#)
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ARDEX Americas.](#)
 - b. [C-Cure.](#)
 - c. [Custom Building Products.](#)
 - d. [LATICRETE SUPERCAP, LLC.](#)
 - e. [MAPEI Corporation.](#)
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

D. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ARDEX Americas.](#)
 - b. [C-Cure.](#)
 - c. [Custom Building Products.](#)
 - d. [LATICRETE SUPERCAP, LLC.](#)
 - e. [MAPEI Corporation.](#)
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15.

2.7 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. High-Performance Tile Grout: ANSI A118.7.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ARDEX Americas.](#)
 - b. [Bostik, Inc.](#)
 - c. [C-Cure.](#)
 - d. [Custom Building Products.](#)
 - e. [LATICRETE SUPERCAP, LLC.](#)
 - f. [MAPEI Corporation.](#)

2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
3. Polymer Type: Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix.

2.8 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
- C. Metal Edge Strips: Angled, rounded, or L-shaped, height to match tile and setting-bed thickness, metallic, designed specifically for flooring and wall applications; bronze exposed-edge material.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Schluter Systems L.P.](#)
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.9 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 2. Verify that concrete substrates for tile floors installed with bonded mortar bed comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match

approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches or larger.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Ceramic Mosaic Tile: 1/8 inch.
 - 2. Porcelain Tile: 1/4 inch.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Metal Edge Strips: Install where indicated in drawings.

3.4 TILE BACKING PANEL INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 WATERPROOFING INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials

over it.

3.6 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.8 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.9 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic Tile Installation: TCNA F111 and ANSI A108.1C; cement mortar bed (thickset) with cleavage membrane.
 - a. Bond Coat for Cured-Bed Method: Improved modified dry-set mortar.
 - b. Grout: High-performance sanded grout.
 - 2. Ceramic Tile Installation: TCNA F121 and ANSI A108.1C; cement mortar bed (thickset) on waterproof membrane.
 - a. Bond Coat for Cured-Bed Method: Improved modified dry-set mortar.
 - b. Grout: High-performance sanded grout.
- B. Interior Wall Installations, Masonry or Concrete:
 - 1. Ceramic Tile Installation: TCNA W202; thinset mortar.
 - a. Thinset Mortar: Improved modified dry-set mortar.
 - b. Grout: High-performance sanded grout.
- C. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. Ceramic Tile Installation: TCNA W244C or TCNA W244F; thinset mortar on cementitious backer units or fiber-cement backer board.
 - a. Thinset Mortar: Improved modified dry-set mortar.
 - b. Grout: High-performance sanded grout.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 3. Hold-Down Clips: Equal to 2 percent of quantity installed.
 4. Impact Clips: Equal to 2 percent of quantity installed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 50 or less.

- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS "CL-1"

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Armstrong World Industries, Inc.](#)
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated. Basis of design Armstrong Cirrus #577
- C. Classification: Provide panels as follows:
1. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 2. Pattern: E (lightly textured), I (embossed).
- D. Color: White.
- E. Light Reflectance (LR): Not less than 0.85.
- F. Ceiling Attenuation Class (CAC): Not less than 35.
- G. Noise Reduction Coefficient (NRC): Not less than 0.35.
- H. Edge/Joint Detail: Beveled Tegal.
- I. Thickness: 3/4 inch.
- J. Modular Size: 24 inches by 24 inches .
- K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEM

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Armstrong World Industries, Inc.](#)
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
- C. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with 9/16-inch- wide faces.
1. Structural Classification: Heavy-duty system.
 2. Face Finish: Painted white.

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less

than 0.106-inch- diameter wire.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Armstrong World Industries, Inc.](#)
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 - 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 - 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 5. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 6. Do not attach hangers to steel deck tabs.
 - 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - 2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 THERMOPLASTIC-RUBBER BASE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Armstrong World Industries, Inc.](#)
 - 2. [Burke Mercer Flooring Products; a division of Burke Industries Inc.](#)
 - 3. [Johnsonite;Tarkett.](#)
 - 4. [Roppe Corporation, USA](#)

- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight.
- C. Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors: As indicated in drawings.

2.3 THERMOPLASTIC-RUBBER ACCESSORIES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. **Mannington Commercial**
 - a. Basis of Design: Rubber Transition Strips, transition from carpet in bedrooms to carpet in corridors, and carpet in corridors to tile in latrines.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
- C. Height: 9.5 mm to 3.2 mm.
- D. Depth: 2.125".
- E. Length: 12'.
- F. Color: As indicated in the drawings.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 4 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 4 inches in length.
 - a. Miter corners to minimize open joints.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes modular carpet tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Carpet tile type, color, and dye lot.
 - 2. Pattern of installation.
 - 3. Pattern type, location, and direction.
 - 4. Transition details to other flooring materials.
- C. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.9 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
 3. Warranty Period: Minimum 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE CPT-1, CPT-2, CP-3

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Bentley Prince Street, Inc.](#)
 2. [Interface, LLC.](#)
 3. [J&J Invision; J&J Industries, Inc.](#)
 4. [Mannington Mills, Inc.](#)
 5. [Milliken & Company.](#)
 6. [Mohawk Group \(The\); Mohawk Carpet, LLC.](#)
 7. [Patcraft; a division of Shaw Industries, Inc.](#)
 8. [Shaw Contract Group; a Berkshire Hathaway company.](#)
- B. Color: As indicated in drawings.
- C. Pattern: As indicated in drawings.
- D. Fiber Content: 100 percent nylon 6.
- E. Fiber Type: Encore SD Ultima (with recycled content).
- F. Pile Characteristic: Textured patterned loop pile.
- G. Density: 5330 oz./cu. yd..
- H. Total Thickness: .312 inches for finished carpet tile.
- I. Stitches: 12.3 stitches per inch.
- J. Gage: 1/12.
- K. Surface Pile Weight: 30 oz./sq. yd..
- L. Size: As indicated on drawings.
- M. Applied Treatments:
1. Soil-Resistance Treatment: Manufacturer's standard treatment.

- N. Performance Characteristics:
1. Pill Test/ DOC-FF-70 (ASTM d-2589) – Requirement: Pass
 2. Flooring Radiant Panel / ASTM E-648 – Requirement: Class 1 (Above .45 w/cm)
 3. CRI VOC Chamber Test/ Indoor Air Quality test (CRI-IAQ) Green Label Plus Test.
 4. Lightfastness: Rating of not less than 5 on International Grey Scale after 40 SFU's when tested in accordance with AATCC Test Method 16E.
 5. Crockfastness: Minimum stain rating on International Grey Scale of not less than 5 wet or dry when tested in accordance with AATCC Test Method 165
 6. Atmospheric Fading: Burned Gas shall not be less than 5 on International Grey Scale after two cycles on each test as per AATCC Test Method 129 Ozone and AATCC Test Method 23

2.2 BROADLOOM CARPET CP-4

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Bentley Prince Street, Inc.](#)
2. [Interface, LLC.](#)
3. [J&J Invision; J&J Industries, Inc.](#)
4. [Mannington Mills, Inc.](#)
5. [Milliken & Company.](#)
6. [Mohawk Group \(The\); Mohawk Carpet, LLC.](#)
7. [Patcraft; a division of Shaw Industries, Inc.](#)
8. [Shaw Contract Group; a Berkshire Hathaway company.](#)

- B. Color: As indicated in drawings.
C. Pattern: As indicated in drawings.
D. Fiber Content: 100 percent nylon 6.
E. Fiber Type: Encore SD Ultima (with recycled content).
F. Pile Characteristic: Textured patterned loop pile.
G. Density: 5330 oz./cu. yd..
H. Total Thickness: .312 inches for finished carpet tile.
I. Stitches: 12.3 stitches per inch.
J. Gage: 1/12.
K. Surface Pile Weight: 30 oz./sq. yd..
L. Size: As indicated on drawings.
M. Applied Treatments:
1. Soil-Resistance Treatment: Manufacturer's standard treatment.

- N. Performance Characteristics:
1. Pill Test/ DOC-FF-70 (ASTM d-2589) – Requirement: Pass
 2. Flooring Radiant Panel / ASTM E-648 – Requirement: Class 1 (Above .45 w/cm)
 3. CRI VOC Chamber Test/ Indoor Air Quality test (CRI-IAQ) Green Label Plus Test.
 4. Lightfastness: Rating of not less than 5 on International Grey Scale after 40 SFU's when tested in accordance with AATCC Test Method 16E.
 5. Crockfastness: Minimum stain rating on International Grey Scale of not less than 5 wet or dry when tested in accordance with AATCC Test Method 165
 6. Atmospheric Fading: Burned Gas shall not be less than 5 on International Grey Scale after two cycles on each test as per AATCC Test Method 129 Ozone and AATCC Test Method 23

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
1. Basis-of-Design Product: J&J Invision TileTabs Connectors for Nexus backed carpet tiles. A glue-free installation which eliminates the need for full spread adhesive. Complies with CRI Green Label Plus (zero calculated emissions).
- C. Metal Edge/Transition Strips: Extruded aluminum with finish of profile indicated in drawings, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 95 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Double sided adhesive tabs. Adhere tabs to concrete substrate and to carpet tile.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.

- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."

- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes modular carpet tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Carpet tile type, color, and dye lot.
 - 2. Pattern of installation.
 - 3. Pattern type, location, and direction.
 - 4. Transition details to other flooring materials.
- C. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.9 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
 - 3. Warranty Period: Minimum 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE CPT-1, CPT-2, CP-3

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Bentley Prince Street, Inc.](#)
 - 2. [Interface, LLC.](#)
 - 3. [J&J Invision; J&J Industries, Inc.](#)
 - 4. [Mannington Mills, Inc.](#)
 - 5. [Milliken & Company.](#)
 - 6. [Mohawk Group \(The\); Mohawk Carpet, LLC.](#)
 - 7. [Patcraft; a division of Shaw Industries, Inc.](#)
 - 8. [Shaw Contract Group; a Berkshire Hathaway company.](#)
- B. Color: As indicated in drawings.
- C. Pattern: As indicated in drawings.
- D. Fiber Content: 100 percent nylon 6.
- E. Fiber Type: Encore SD Ultima (with recycled content).
- F. Pile Characteristic: Textured patterned loop pile.

- G. Density: 5330 oz./cu. yd..
- H. Total Thickness: .312 inches for finished carpet tile.
- I. Stitches: 12.3 stitches per inch.
- J. Gage: 1/12.
- K. Surface Pile Weight: 30 oz./sq. yd..
- L. Size: As indicated on drawings.
- M. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.
- N. Performance Characteristics:
 - 1. Pill Test/ DOC-FF-70 (ASTM d-2589) – Requirement: Pass
 - 2. Flooring Radiant Panel / ASTM E-648 – Requirement: Class 1 (Above .45 w/cm)
 - 3. CRI VOC Chamber Test/ Indoor Air Quality test (CRI-IAQ) Green Label Plus Test.
 - 4. Lightfastness: Rating of not less than 5 on International Grey Scale after 40 SFU's when tested in accordance with AATCC Test Method 16E.
 - 5. Crockfastness: Minimum stain rating on International Grey Scale of not less than 5 wet or dry when tested in accordance with AATCC Test Method 165
 - 6. Atmospheric Fading: Burned Gas shall not be less than 5 on International Grey Scale after two cycles on each test as per AATCC Test Method 129 Ozone and AATCC Test Method 23

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
 - 1. Basis-of-Design Product: J&J Invision TileTabs Connectors for Nexus backed carpet tiles. A glue-free installation which eliminates the need for full spread adhesive. Complies with CRI Green Label Plus (zero calculated emissions).
- C. Metal Edge/Transition Strips: Extruded aluminum with finish of profile indicated in drawings, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 95 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Double sided adhesive tabs. Adhere tabs to concrete substrate and to carpet tile.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 099113 - EXTERIOR

PAINTING PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Steel.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.
 - 2. Section 092423 "Cement Stucco" for exterior stucco finish and construction.

1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Benjamin Moore & Co.
 - 2. Kelly-Moore Paints.
 - 3. Pratt & Lambert.
 - 4. Sherwin-Williams Company (The). Basis of design.
 - 5. Zinsser.
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.
- D. Colors: Exterior paint of Cement Stucco to match existing Fire Station as much as possible. Coordinate with GAFB for Base Standard Colors and RGB values.

2.3 PRIMERS/SEALERS

- A. Primer, Alkali Resistant, Water Based.
- B. Primer, Bonding, Water Based.

2.4 METAL PRIMERS

- A. Primer, Alkyd, Quick Dry, for Metal.

2.5 WATER-BASED PAINTS

- A. Latex, Exterior Low Sheen (Gloss Level 3-4):
- B. Latex, Exterior Semi-Gloss (Gloss Level 5):
- C. Light Industrial Coating, Exterior, Water Based (Gloss Level 3):

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

- B. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
 - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
 - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Paint All Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work, where exposed to view.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. Steel –Exposed Steel:
 - 1. Primer: S-W Pro Industrial Pro-Cryl Universal primer Off White;
 - 2. 2 Coats: S-W Sher-Cryl HPA High Performance Acrylic Gloss Coating; Or equal.
 - 3. Finish Color: "Sealskin" SW7675 by Sherwin Williams or approved eq.
- B. Exterior Doors:
 - 1. Primer: S-W Pro Industrial Pro-Cryl Universal primer Off White;
 - 2. 2 Coats: S-W Sher-Cryl HPA High Performance Acrylic Gloss Coating; Or equal.
 - 3. Finish: Color: "Sealskin" SW7675 by Sherwin Williams or approved eq.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Steel and iron.
 - 2. Gypsum board.

1.2 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product or approved equal listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

- C. Colors: As indicated in a color schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 INTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 1. Water-Based Acrylic Industrial Coating System:
 - a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
 - b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, interior, water based, semi-gloss (MPI Gloss Level 5), MPI #153.
- B. Gypsum Board Substrates:
 - 1. Latex over Latex Sealer System:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

END OF SECTION 099123

SECTION 101419 - DIMENSIONAL LETTER

SIGNAGE PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cast dimensional characters.

1.3 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign.
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: **Full-size Sample of one character**
 - 2. Exposed Accessories: **Full-size Sample** of each accessory type.
 - 3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.
- D. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - 2. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIMENSIONAL CHARACTERS

- A. Cut Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.R.K. Ramos.
 - b. ASI Sign Systems, Inc.
 - c. Gemini Incorporated.
 - d. Metal Arts.
 - e. Southwell Company (The).
2. Character Material: Extruded aluminum.
3. Character Height: 6" min.
4. Finishes: Anodized Dark Bronze
5. Font: Helvetica Neue in accordance with UFC 3-120-01 Signage Standard for Building Entrance Signage

B. DIMENSIONAL CHARACTER MATERIALS

1. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
2. ACCESSORIES
 - a. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 - b. Use concealed fasteners.
 - c. For exterior exposure, furnish hot-dip galvanized devices unless otherwise indicated.
 - d. Sign Mounting Fasteners:
 - Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

3.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

PART 3 - EXECUTION

2.2 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

- B. Mounting Methods:
 - 1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

- B. Remove temporary protective coverings and strippable films as signs are installed.

- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Room-Identification Signs and Materials: Provide manufacturer's standard size physical samples for all exposed materials in each color and finish.
- D. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Variable Component Materials: 4 replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
 - 2. Tools: One set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design," the ABA standards of the Federal agency having jurisdiction, ICC A117.1, and UFC 3-120-01 Signage Standard.

2.2 ROOM-IDENTIFICATION SIGNS

- A. Room-Identification Sign: Sign system with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Rowmark
 - b. 2/90 Sign System
 - c. ASI Sign Systems, Inc.
 - d. Inpro Corporation.
 - 2. Solid-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
 - b. Color(s): Provide Dark bronze or Dark Brown background with white lettering.
 - 3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Square cut.
 - b. Corner Condition in Elevation: Square.
 - 4. Mounting: Surface mounted to wall or glass with two-face tape.
 - 5. Text and Typeface: Accessible raised characters and Braille, Helvetica Neue. Finish raised characters to contrast with background color, and finish Braille to match background color.

2.3 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

2.4 ACCESSORIES

- A. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- C. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
 - 1. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.
- C. Mounting Methods:
 - 1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position and push to engage tape adhesive.
- D. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.2 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions. Touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.16

SECTION 10 21 13 TOILET COMPARTMENTS

PART 1.0 – GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
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ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167 (2011) Standard	Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A336/A336M	(2021) Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts
ASTM A385/A385M	(2020) Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM B36/B36M	(2018) Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B86	(2018; E 2021) Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings
ASTM B221	(2020) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities
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U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003	(Basic) Partitions, Toilet, Complete
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U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines
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1.2 ACTION SUBMITTALS

SD-01 Shop Drawings: Provide partition plans, elevation views, dimensions, and details of wall and floor supports, fabrication drawings, and manufacturer installation drawings.

SD-02 Product Data: Provide panel construction information, hardware information, brackets, accessories information, and cleaning and maintenance Instructions

SD-03 Colors and Finishes: Provide (2) 2"x2" samples indicating panel finish, color, and sheen along with hardware and bracket finish and sheen.

1.3 INFORMATION SUBMITTALS

SD-04 Certificates and Warranty

1.4 REGULATORY REQUIREMENTS

- A. Comply with to ICC A117.1 code for access for the handicapped operation of toilet compartment door and hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in the manufacturer's original unopened packages with the brand, item identification, and project reference clearly marked.
- B. Store components in a dry location that is adequately ventilated; free from dust, water, other contaminants, and damage during delivery, storage, and construction.

1.6 WARRANTY

- A. Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of one year from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Provide a complete and usable toilet partition system, including toilet enclosures, room entrance screens, urinal screens, system of panels, hardware, and support components. Furnish the partition system from a single manufacturer, with a standard product as shown in the most recent catalog data. Submit Fabrication Drawings for toilet partitions and urinal screens consisting of fabrication and assembly details to be performed in the factory. Submit manufacturer's Cleaning and Maintenance Instructions in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.2 MATERIALS

2.2.1 Solid Polyethylene Panels (Finish 5)

- A. Provide high density polyethylene (HDPE) suitable for exposed application. Waterproof, non-absorbent and graffiti resistant textured surface with a Flame Spread Index of 75 or less, and a Smoke Developed Index of 450 or less.
- B. Finish: As indicated on drawings

2.2.2 Anchoring Devices and Fasteners

- A. Provide steel anchoring devices and fasteners hot-dipped galvanized after fabrication, in conformance with ASTM A385/A385M and ASTM A123/A123M. Conceal all galvanized anchoring devices.
- B. Brackets: Provide two-ear panel wall brackets, T-style, 1 inch stock. Provide stirrup style panel-to-pilaster brackets.

2.2.3 Hardware and Fittings

2.2.3.1 General Requirements

- A. Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. Provide hardware finish highly resistant to alkalis, urine, and other common toilet room acids. Comply with 36 CFR 1191 of latching devices and hinges for handicap compartments; provide stainless steel devices and hinges with door latches that operate without either tight grasping or twisting of the wrist of the operator. Submit three samples of each item, including anchoring devices and fasteners. Approved hardware samples may be installed in the work if properly identified.

Material	Conformance Standard
Cold-rolled sheet steel	ASTM A336/A336M, commercial quality
Zinc-base alloy	ASTM B86, Alloy AC41-A
Brass	ASTM B36/B36M, Alloy C26800
Aluminum	ASTM B221
Corrosion-resistant steel	ASTM A167, Type 304

2.2.3.2 Finishes

- A. Provide stainless steel with a No. 4 finish.
- B. Provide exposed fasteners that match the hardware and fittings.

2.2.4 Door Hardware

2.2.4.1 Hinges

- A. Provide adjustable hinges to hold in-swinging doors open at any angle up to 90 degrees and outswinging doors up to 10 degrees. Provide self-lubricating hinges with the indicated swing. Provide hinges that are exposed pivot and have Gravity return type of return movement.

2.2.4.2 Latch and Pull

Provide latch and pull that is a combination rubber-faced door strike and keeper equipped with emergency access. Provide surface mounted latch.

2.2.4.3 Coat Hooks

- A. Provide coat hooks that are combination units with hooks and rubber tipped pins.

2.3 PARTITION PANELS AND DOORS

- A. Fabricate partition panels, and pilasters of materials and construction listed:

 Provide plastic (HDPE) partition panels, doors and pilasters not less than 1 inch thick. Provide solid polyethylene toilet partitions and screens with recycled content of 30 percent minimum.

2.3.1 Toilet Enclosures

- A. Provide toilet enclosures that comply with CID A-A-60003, Type I, Style C, overhead braced. Furnish width, length, and height of toilet enclosures as shown. Finish surface of panels are solid polyethylene (Finish 5); water resistant; graffiti resistant; non-absorbent radius beveled edges. Reinforce panels indicated to receive toilet paper holders or grab bars for mounting of the items required, and provide cut outs for through partition toilet accessories. Provide grab bars to withstand a bending stress, shear stress, shear force, and a tensile force induced by 250 lbf. Grab bars cannot rotate within their fittings.

2.4 OVERHEAD-BRACED PARTITIONS

- A. Provide pilasters in sizes indicated that are manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism. Provide anchoring device at the bottom of the pilaster consisting of a channel-shaped floor stirrup fabricated from not less than 0.0635 inch thick material and a leveling bolt. Secure the stirrup to the pilaster with not less than a 3/16 inch bolt and nut after the pilaster is leveled. Secure the stirrup to the floor with not less than two lead expansion shields and sheet metal screws. Fabricate overhead brace from a continuous extruded aluminum tube not less than 1 inch wide by 1-1/2 inch high, 0.125 inch wall thickness. Finish is AA-C22A31 in accordance with AA DAF45. Set and secure brace into the top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

2.5 PILASTER SHOES

- A. Provide shoes at pilasters to conceal floor-mounted anchorage. Provide one piece molded HDPE pilaster shoes. Height is a minimum 3 inches.

2.6 HARDWARE

- A. Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. Provide hardware pre-drilled by manufacturer. Use a hardware finish that is highly resistant to alkalis, urine, and other common toilet room acids. Provide latching devices and hinges for handicap compartments complying with 36 CFR 1191 and stainless steel door latches that operate without either tight grasping or twisting of the wrist of the operator. Use stainless steel, tamper proof type screws and bolts. Wall mounting brackets are continuous, full height, stainless steel, in accordance with toilet compartment manufacturer's instructions. Provide floor-mounted anchorage consisting of corrosion-resistant anchoring assemblies with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor.

2.7 COLORS AND FINISHES

2.7.1 Colors

- A. Provide color as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.
- B. Color of pilaster shoes matches the core of solid plastic compartments and screens. Submit three samples showing color and a finished edge on two adjacent sides and core construction, each not less than 12 inch square.

2.7.2 Finishes

2.7.2.1 Finishes No. 4, No 4A and No. 5

- A. Provide manufacturer's standard solid polyethylene (Finish 5] formed under high pressure rendering a single component section not less than 1 inch thick. Colors extend throughout the panel thickness.

PART 3 EXECUTION

3.1 PREPARATION

- A. Take field measurements prior to the preparation of drawing and fabrication to ensure proper fits. Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work. Verify correct spacing of plumbing fixtures. Verify correct location of built in framing, anchorage, and bracing. Report in writing to Contracting Officer prevailing conditions that adversely affect satisfactory execution of the work of this section. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install items that show visual evidence of biological growth. Install partitions rigid, straight, plumb, and level, with the panels centered between the fixtures. Provide a panel clearance of not more

than 1/2 inch and secure the panels to walls and pilasters with continuous full height wall brackets. Locate wall brackets so that holes for wall bolts occur in masonry or tile joints. Secure panels to pilasters with brackets matching the wall brackets. Provide for adjustment due to minor floor variations. Locate head rail joints at pilaster center lines. Install adjacent components for consistency of line and plane. Equip each door with hinges, one door latch, and one coat hook and bumper. Align hardware to uniform clearance at vertical edges of doors.

- Secure panels to hollow plastered walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 600 pounds per anchor.
- Secure panels to ceramic tile on hollow plastered walls or hollow concrete-masonry walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 600 pounds per anchor.
- Secure panels to solid masonry or concrete with lead or brass expansion shields designed for use with not less than 1/4-20 screws, with a shield length of not less than 1-1/2 inches. Provide expansion shields with a load-carrying strength of not less than 600 pounds per anchor.
- Submit Installation Drawings for toilet partitions, room entrance screens, and urinal screens showing plans, elevations, details of construction, hardware, reinforcing and blocking, fittings, mountings and escutcheons. Indicate on drawings the type of partition, location, mounting height, cutouts, and reinforcement required for toilet-room accessories.

3.3 FLOOR-ANCHORED PARTITIONS

Secure pilasters to the floor with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Level tops of doors with tops of pilasters when doors are in a closed position. Expansion shields have a minimum 2 inch penetration into the concrete slab.

3.4 OVERHEAD-BRACED PARTITIONS

Secure pilasters to the floor with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Secure overhead brace to the pilaster face with not less than two fasteners per face. Expansion shields have a minimum 2 inch penetration into the concrete slab. Make tops of doors parallel with the overhead brace when doors are in a closed position.

3.5 FINAL ADJUSTMENT

After completion of the installation, make final adjustments to the pilaster-leveling devices, door hardware, and other working parts of the partition assembly. Doors have a uniform vertical edge clearance of approximately 3/16 inch and rest open at approximately 30 degrees when unlatched.

3.6 CLEANING

Touch up baked enamel and powder coat finish with the same color of paint that was used for the finish. Clean all surfaces and adjacent surfaces soiled as a result of the work, in an approved manner compliant with the manufacturer's recommended cleaning and protection from damage procedures until accepted. Remove all equipment, tools, surplus materials, and work debris from the site.

End of Section 102113

SECTION 10 26 00 WALL AND DOOR PROTECTION

PART 1.0 – GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B221 (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use SCIENTIFIC
CERTIFICATION SYSTEMS (SCS)
SCS SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications
UNDERWRITERS LABORATORIES (UL)
UL 2818 (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 ACTION SUBMITTALS

SD-01 Product Data: Manufacturer's descriptive data, catalog cuts, installation instructions, and recommended cleaning instructions.

SD-02 Samples: Three samples indicating color and texture of material requiring color and finish.

1.3 INFORMATION SUBMITTALS

SD-03 Test Reports: Fire Resistance Rating and extinguishing test results for resilient material.

SD-04 Certificates: Statements attesting that the items comply with the specified fire and safety code requirements.

1.3 CERTIFICATIONS

1.3.1 Adhesives and Sealants

- A. Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and trademarks intact. Keep materials dry, protected from weather and damage, and stored under cover. Store materials at approximately 70 degrees F for at least 48 hours

prior to installation.

1.5 WARRANTY

- A. Provide manufacturer's warranty to repair or replace defective materials and workmanship for a 1 year period of one year from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

- A. To the maximum extent possible, provide wall and door protection items that are standard products of a single manufacturer and furnished as detailed. Drawings show general configuration of products required, and items differing in minor details from those shown are acceptable.

2.2 CORNER GUARDS

2.2.1 Corner Guards

- A. Provide anodized aluminum surface mounted corner guards, radius formed to profile shown. Provide corner guards that are 4 feet high. Furnish mounting hardware, cushions, and base plates. Provide assembly consisting of a snap-on corner guard formed from high impact resistant resilient material, mounted on a continuous aluminum retainer. Extruded aluminum retainer conforms to ASTM B221, alloy 6063, temper T5 or T6. Furnish factory fabricated end closure caps for top and bottom of surface mounted corner guards.
- B. Leg Size: As indicated on drawings
- C. Guard Finish: As indicated on drawings

2.3 TRIM, FASTENERS AND ANCHORS

- A. Provide fasteners and anchors for each specific installation per manufacturer's instructions.

2.4 FINISH

- A. Submit samples indicating stainless steel or brushed aluminum color and texture of materials.

2.5 ADHESIVES

- A. Provide adhesive for resilient material in accordance with manufacturers recommendations. Provide sealants and non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) the VOC content requirements of SCAQMD Rule 1168, or VOC content requirements of GS-36. Provide certification of indoor air quality for adhesives.

PART 3.0 EXECUTION

3.1 INSTALLATION

- A. Do not install items that show visual evidence of biological growth. Install items on surfaces that are clean, smooth, and free of obstructions.

3.1.1 Corner Guards and Wall Guards

- A. Mount and fasten guards on external corners of interior walls, partitions and columns and in accordance with manufacturer's written installation instructions. Contractor shall ensure guards are secured to partitions and not protruding beyond manufacturer defined dimensions.

-- End of Section --

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Childcare accessories.
 - 3. Under-lavatory guards.

1.3 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Samples: Full size, for each exposed product and for each finish specified.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED MATERIALS

- A. Owner-Furnished, Contractor-Installed Materials: Toilet paper dispenser, Paper towel dispenser, Soap dispenser.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Waste Receptacle:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [American Specialties, Inc.](#)
 - b. [Bobrick Washroom Equipment, Inc.](#)
 - c. [Bradley Corporation.](#)
 - d. [GAMCO Specialty Accessories; a division of Bobrick.](#)
 - 2. Mounting: Freestanding.
- C. Grab Bars:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [American Specialties, Inc.](#)
 - b. [Bobrick Washroom Equipment, Inc.](#)
 - c. [Bradley Corporation.](#)
 - d. [GAMCO Specialty Accessories; a division of Bobrick.](#)
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4 finish (satin).
 - 4. Outside Diameter: 1-1/2 inches.
 - 5. Configuration and Length: As indicated on Drawings.
- D. Sanitary-Napkin Disposal Unit:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [American Specialties, Inc.](#)
 - b. [Bobrick Washroom Equipment, Inc.](#)
 - c. [Bradley Corporation.](#)
 - d. [GAMCO Specialty Accessories; a division of Bobrick.](#)
 - 2. Mounting: Surface mounted.
 - 3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
 - 4. Receptacle: Removable.
 - 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- E. Seat-Cover Dispenser:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [American Specialties, Inc.](#)
 - b. [Bobrick Washroom Equipment, Inc.](#)
 - c. [Bradley Corporation.](#)
 - d. [GAMCO Specialty Accessories; a division of Bobrick.](#)
 - 2. Mounting: Surface mounted.
 - 3. Minimum Capacity: 250 seat covers.
 - 4. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).
 - 5. Lockset: Tumbler type.
- F. Mirror:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [American Specialties, Inc.](#)
 - b. [Bobrick Washroom Equipment, Inc.](#)
 - c. [Bradley Corporation.](#)
 - d. [GAMCO Specialty Accessories; a division of Bobrick.](#)
 - 2. Frame: Stainless-steel angle, 0.05 inch thick.
 - a. Corners: Manufacturer's standard.
 - 3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - 4. Size: As indicated on Drawings.

2.3 CHILDCARE ACCESSORIES

- A. Source Limitations: Obtain childcare accessories from single source from single manufacturer.
- B. Diaper-Changing Station:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Specialties, Inc.
 - b. GAMCO Specialty Accessories; a division of Bobrick.
 - c. Koala Kare Products.
 - 2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of 250-lb static load when opened.
 - 3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
 - 4. Operation: By pneumatic shock-absorbing mechanism.
 - 5. Material and Finish: Stainless steel, No. 4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer's standard color.
 - 6. Liner Dispenser: Built in.

2.4 UNDERLAVATORY GUARDS

- A. Underlavatory Guard:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Buckaroos, Inc.
 - b. Plumberex Specialty Products, Inc.
 - c. Truebro by IPS Corporation.
 - 2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
 - 3. Material and Finish: Antimicrobial, molded plastic, white.

2.5 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- C. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- D. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- E. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 105220 – FIRE EXTINGUISHER AND CABINET

PART 1.0 – GENERAL

1.1 INFORMATION SUBMITTALS

- A. Manufacturer's descriptive data and installation instructions

1.2 DELIVERY AND STORAGE

- A. Materials shall be delivered to the building site in original unopened containers, shall be stored in a clean dry area prior to installation and shall be stacked according to the manufacturer's recommendations.

1.3 SCHEDULING

- A. Fire extinguisher and cabinet installation shall be scheduled after the completion of other work that could potentially damage the finish surface of the fire extinguisher and fire extinguisher cabinet.

PART 2 – PRODUCTS

2.1 FIRE EXTINGUISHER AND CABINET [Per NFPA 10]

- A. Fire extinguisher equal to Amerex #A456 Dry Chemical (Ammonia Phosphate Base), 10 pound, 4-A: 60-B: C. Rechargeable, ANSI/UL 299, CAN/ULC-5304-M86.

- B. Fire extinguisher cabinet for this project shall be equal to Panorama Series #1016C70 with Futura handle as manufactured by J.L. Industries. Stainless Steel finish.

PART 3.0 – EXECUTION

3.1 INSTALLATION:

- A. Install fire extinguishers and cabinets at locations indicated on the plans, in accordance with Code requirements and with the manufacturer's recommended cleaning products and procedures.

END OF SECTION 105220

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, and methods of joining.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [E. I. du Pont de Nemours and Company.](#)
 - b. [Formica Corporation.](#)
 - c. [LG Chemical, Ltd.](#)
 - d. [Samsung Chemical USA, Inc.](#)
 - e. [Wilsonart LLC.](#)
2. Type: Provide Standard type unless Special Purpose type is indicated.
3. Colors and Patterns: As indicated in drawings.

B. **Composite Wood Products:** Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

1. Underlayment to be 3/4" thick Medium Density Fiberboard.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 1. Grade: Custom.
- B. Configuration:
 1. Front: Beveled.
 2. Backsplash: Beveled.
- C. Countertops: 1/2-inch- thick, solid surface material with front edge built up with same material.
- D. Backsplashes: 1/2-inch- thick, solid surface material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate countertops without joints.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Secure countertops to MDF subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- C. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- D. For countertops with waterfall edges, provide concealed steel brackets and space as required by mfr.
- E. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 13 34 19 - METAL BUILDING SYSTEMS

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 within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA/WDMA/CSA 101/I.S.2/A440		(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights
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AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325		(2017) Steel Construction Manual
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AISC 360		(2016) Specification for Structural Steel Buildings
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AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121		(2007) Standard Definitions for Use in the Design of Steel Structures
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AISI D100		(2017) Cold-Formed Steel Design Manual
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AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16		(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
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AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 – SI		(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
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AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M		(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
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AWS D1.1/D1.1M		(2020; Errata 1 2021) Structural Welding Code - Steel
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AWS D1.3/D1.3M		(2018) Structural Welding Code - Sheet Steel
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ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M		(2019) Standard Specification for Carbon Structural Steel
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ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529/A529M	(2019) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A572/A572M	(2021; E 2021) Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M (2023) Standard Specification for Steel	Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	

(2014) Standard Specification for Aluminum and

Aluminum-Alloy Sheet and Plate

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C665	(2023) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C1363	(2019) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paint
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinate
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100? Percent Relative Humidity
ASTM D2794	

(1993; R 2019) Standard Test Method for	Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D5359	(1998; R 2021) Standard Specification for Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber
ASTM DEFONLINE	(2008) ASTM Online Dictionary of Engineering Science and Technology
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2022) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2022) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM F436/F436M	(2019) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1852	(2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch

Dimensions 120 ksi and 150 ksi Minimum
 Tensile Strength, and Metric Dimensions 830

MPa and 1040 MPa Minimum Tensile
 Strength

ASTM G152

(2013; R 2021) Standard Practice for
 Operating Open Flame Carbon Arc Light
 Apparatus for Exposure of Nonmetallic
 Materials

ASTM G153

(2013; R 2021) Standard Practice for
 Operating Enclosed Carbon Arc Light
 Apparatus for Exposure of Nonmetallic
 Materials

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM

(2018) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500

(2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80

(2022) Standard for Fire Doors and Other
 Opening Protectives

NFPA 252

(2022) Standard Methods of Fire Tests of
 Door Assemblies

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan

(2020) The NRCA Roofing Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793

(2012) Architectural Sheet Metal Manual, 7th
 Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 15

(1999; E 2004) Steel Joist
 Shop Primer/Metal Building
 Primer

SSPC Painting
 Manual

(2002) Good Painting Practice, Steel
 Structures Painting Manual, Volume 1

SSPC SP 2 (2018) Hand Tool Cleaning
 SWI AGSW

STEEL WINDOW INSTITUTE (SWI)
 (2002) Architect's Guide to Steel
 Windows U.S. ARMY CORPS OF
 ENGINEERS (USACE)

EM 385-1-1

(2014) Safety -- Safety and Health

Requirements Manual

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01

(2023) Structural Engineering

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir

(updated continuously online) Building
Materials Directory

1.2 GENERAL REQUIREMENTS

- A. Design Parameters
 - 1. Design and construct pre-engineered metal buildings of size, shape, height, fenestration, siting, and configuration indicated. Coordinate site utility services, accessibility requirements, vehicular and pedestrian access, mechanical, electrical, plumbing and fire protection requirements, interior construction and finishes, and such other items as may be necessary for a complete, functional building.
- B. Structural Performance
 - 1. Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and conditions indicated.
 - 2. Engineering
 - a. Design metal building systems conforming to procedures described in MBMA MBSM.
 - 3. Design Loads
 - a. Design and construct to the requirements of UFC 3-301-01, Structural Engineering.
- C. Thermal Performance – N/A
- D. Water Penetration for Metal Roof Panels
 - 1. No water penetration when tested according to ASTM E1646 at test-pressure difference of 2.86 lbf/sq.ft.
- E. Wind-Uplift Resistance
 - 1. Design for wind-uplift resistance in accordance with UFC 3-301-01.
- F. Erection Plan
 - 1. Provide plans and a written erection/lifting procedure with required plans clearly showing the intended sequence and method of erection in accordance with EM 385-1-1 "Safety - Safety and Health Requirements". Indicate required crane lifting requirements, temporary support structures, member size and locations of braced or guyed temporary supports, and locations of bracing or guys anchor points. Clearly define the required framing sequence and conditions necessary to ensure the structure is maintained in a properly braced and stable condition throughout the complete erection process.

1.3 DEFINITIONS

- A. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face of end-wall girt) for end bays.
- B. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).
- C. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).
- D. Terminology Standard: Refer to MBMA "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

- A. General: Provide a complete, integrated set of [metal building system manufacturer's standard] mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, [metal roof panels] and accessories complying with requirements indicated.

Provide metal building system of size and with spacing, slopes, and spans indicated.
- B. Primary Frame Type
 - 1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
- C. Fixed End-Wall Framing
 - 1. Provide manufacturer's standard fixed end wall, for buildings not required to be expandable, consisting of primary frame, load-bearing end-wall with corner columns, and rafters.
- D. Expandable End-Wall Framing - Not Used
- E. Secondary Frame Type
 - 1. Provide manufacturer's standard purlins and joists and flush-framed girts.
- F. Eave Height
 - 1. Eave height must be 10' – 10" or Manufacturer's standard height, as indicated by nominal height on Drawings.
- G. Bay Spacing – Not Used
- H. Roof Slope
 - 1. Roof slope must be 3 inch per 12 inches or manufacturer's standard for frame type required].
- I. Roof System
 - 1. Provide manufacturer's standard vertical-rib, standing-seam metal roof panels. Refer to Section 074113.16 Standing Seam Metal Roof Panels.
- J. Exterior Wall System – Refer to dwg. Sht. A-802 for partition types.

1.5 ACTION SUBMITTALS

- A. Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
- B. SD-02 Shop Drawings
 - 1. Detail Drawings
 - 2. Erection Plan
- C. SD-03 Product Data
 - 1. Manufacturer's Catalog Data
 - 2. Recycled Content for Structural Steel Shapes and Plates
 - 3. Recycled Content for Steel Pipe
 - 4. Recycled Content for Steel Sheet Materials
 - 5. Recycled Content for Insulation Materials
- D. SD-04 Samples
 - 1. Roof Panels, 304.8 mm 12 inches long by actual panel width
 - 2. Manufacturer's Color Charts and Chips, 101.6 mm by 101.6 mm 4 by 4 inches
- E. SD-11 Closeout Submittals
 - 1. Manufacturer's Warranty
 - 2. Contractor's Warranty for Installation

1.6 INFORMATION SUBMITTALS

- A. SD-01 Preconstruction Submittals
 - 1. Manufacturer's Qualifications
- B. SD-05 Design Data
 - 1. Manufacturer's Descriptive and Technical Literature
 - 2. Lateral Force Calculations
- C. SD-06 Test Reports
 - 1. Coatings and Base Metals
 - 2. Factory Color Finish Performance Requirements
- D. SD-07 Certificates
 - 1. System Components
 - 2. Coil Stock Certificates
 - 3. Qualification of Manufacturer
 - 4. Qualification of Erector
- E. SD-08 Manufacturer's Instructions
 - 1. Installation of Roof
 - 2. Shipping, Handling, and Storage

1.7 QUALITY ASSURANCE

- A. Pre-Erection Conference
 - 1. After submittals are received and approved but before metal building system work, including associated work, is performed, the Contracting Officer will hold a pre-erection conference to review the following:
 - a. The detail drawings, specifications, and manufacturer's descriptive and technical literature.
 - b. Finalize construction schedule and verify availability of materials, erector's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Methods and procedures related to metal building system erection, including, but not limited to: qualification of manufacturer, qualification of erector, manufacturer's catalog data, manufacturer's building design analysis, lateral force calculations, written instructions and test reports. Lateral force calculations must include all analysis and confirmation of system components required to transfer lateral forces to the foundation.
 - d. Support conditions for compliance with requirements, including alignment between and erection of structural members.
 - e. Flashing, special roofing and siding details, roof and wall penetrations, openings, and condition of other construction that will affect the metal building system, including coatings and base metals, factory color finish performance requirements, system components, and coil stock certificates.
 - f. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.
 - g. Temporary protection requirements for metal panel assembly during and after installation.
 - h. Samples of roof panels, wall panels, aluminized steel repair paint, galvanizing repair paint, and enamel repair paint.
- B. Pre-Roofing and Siding Installation Conference
 - 1. After structural framing system erection and approval but before roofing, insulation and vapor barrier work, including associated work, is performed; the Contracting Officer will hold a pre-roofing

and siding conference to review the following:

- a. Examine purlins, sub-girts and formed shapes conditions for compliance with requirements, including flatness and attachment to structural members.
 - b. Review structural limitations of purlins, sub-girts and formed shapes during construction and after roofing and siding.
 - c. Review flashings, special roof and wall details, roof drainage, roof and wall penetrations, roof equipment curbs, and condition of other construction that will affect the metal building system.
 - d. Review temporary protection requirements for metal roof and wall panels' assembly during and after installation.
 - e. Review roof and wall observation and repair procedures after metal building system erection.
- C. Manufacturer's Technical Representative
1. The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products, erection of structural framing and installation of roof and wall panels in the geographical area where construction will take place.
- D. Manufacturer's Qualifications
1. Metal building system manufacturer must have a minimum of five years experience as a qualified manufacturer and a member of MBMA of metal building systems and accessory products.
 2. Provide engineering services by an authorized currently licensed engineer in the geographical area where construction will take place, having a minimum of four years experience as an engineer knowledgeable in building design analysis, protocols and procedures for the "Metal Building Systems Manual" (MBMA MBSM); ASCE 7-16,[the building code in the geographic area where the construction will take place] and ASTM E1592. Provide certified engineering calculations using the products submitted for:
 - a. Roof and Wall Wind Loads with basic wind speed, exposure category, co-efficient, importance factor, designate type of facility, negative pressures for each zone, methods and requirements of attachment.
 - b. Roof Dead and Live Loads
 - c. Collateral Loads
 - d. Foundation Loads
 - e. Roof Snow Load
 - f. Seismic Loads
- E. Qualification of Erection Contractor
1. An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and must be approved and certified by the metal building system manufacturer.
- F. Single Source
1. Obtain primary and secondary components and structural framing members, each type of metal roof, wall and liner panel assemblies, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.
- G. Welding
1. Qualify procedures and personnel according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M.

- H. Structural Steel
 - 1. Comply with AISC 325, AISC 360, for design requirements and allowable stresses.
- I. Cold-Formed Steel
 - 1. Comply with AISC/AISI 121 and AISI D100 for design requirements and allowable stresses.
- J. Fire-Resistance Ratings
 - 1. Where indicated, provide metal panels identical to those of assemblies tested for fire resistance in accordance with ASTM E119, as certified by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 2. Indicate design designations from UL Bld Mat Dir or from the listings of another qualified testing agency. Combustion Characteristics must conform to ASTM E136.
- K. Surface-Burning Characteristics
 - 1. Provide metal panels having field-insulation and vapor barrier material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency showing:
 - a. Flame-Spread Index: 25 minimum.
 - b. Smoke-Developed Index: 450 minimum.
- L. Fabrication
 - 1. Fabricate and finish metal panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements.
 - 2. Comply with indicated profiles with dimensional and structural requirements. Provide metal panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Aluminum and aluminum-alloy sheet and plate must conform to ASTM B209. Fabricate metal panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.
 - 3. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:
 - a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal building system manufacturer for application, but not less than thickness of metal being secured.
- M. Finishes
 - 1. Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.
 - 2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.8 SHIPPING, HANDLING AND STORAGE

- A. Delivery

1. Package and deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

B. Storage

1. Stack and store metal panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Store in a manner to prevent bending, warping, twisting, and surface damage. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage. Retain strippable protective covering on metal panel for entire period up to metal panel installation.

1.9 PROJECT CONDITIONS

A. Weather Limitations

1. Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing panel system or building.

B. Field Measurements

1. Established Dimensions for Foundations

- a. Comply with established dimensions on approved anchor-bolt plans, established foundation dimensions, and proceed with fabricating structural framing. Do not proceed without verifying field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

2. Established Dimensions for Metal Panels

- a. Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

3. Verification Record

- a. Verify locations of all framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on Shop Drawings.

1.10 COORDINATION

- A. Coordinate final design and placement of foundation between structural engineer of record, and Contractor. Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in section on CAST-IN-PLACE CONCRETE.
- B. Coordinate installation of [fire suppression system] [equipment supports] [piping and supports][and][accessories], which are specified in Division 21 - FIRE SUPPRESSION.
- C. Coordinate installation of [plumbing system] [equipment supports] [piping and supports] [and] [accessories], which are specified in Division 22 - PLUMBING.
- D. Coordinate installation of [HVAC system] [equipment supports] [ductwork and supports] [piping and supports][and][accessories], which are specified in Division 23 - MECHANICAL
- E. Coordinate installation of [roof curbs] [equipment supports][and][roof penetrations], which are specified in Division 07 - THERMAL AND MOISTURE PROTECTION.
- F. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.11 WARRANTY

- A. Building System Warranty

1. Furnish manufacturer's no-dollar-limit warranty for the metal building system. The warranty period is to be no less than 20 years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that if within the warranty period, the metal building system shows evidence of deterioration resulting from defective materials or workmanship, correcting of any defects is the responsibility of the metal building system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal building system is under warranty are to be performed within 72 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 72 hours of notification will constitute grounds for having emergency repairs performed by others and will not void the warranty.
- B. Roof System Weather-Tightness Warranty
1. Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than 20 years from the date of acceptance of the work and be issued directly to the Government.
 2. The warranty is to provide that if within the warranty period the roof panel system shows evidence of corrosion, perforation, rupture, loss of weather-tightness or excess weathering due to deterioration of the panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.
 3. Repairs that become necessary because of defective materials and workmanship while roof panel system is under warranty are to be performed within 24 hours after notification unless additional time is approved by the Contracting Officer. Failure to perform temporary repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty. Immediate follow-up and completion of permanent repairs must be performed within 3 days from date of notification.
- C. Roof and Wall Panel Finish Warranty
1. Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than 30 years from the date of acceptance of the work and be issued directly to the Government.
 2. The warranty is to provide that if within the warranty period the metal panel system shows evidence of checking, delaminating cracking, peeling, chalk in excess of a numerical rating of eight, as determined by ASTM D4214 test procedures; or change colors in excess of five CIE or Hunter units in accordance with ASTM D2244 or excess weathering due to deterioration of the panel system resulting from defective materials and finish or correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.
 3. Liability under this warranty is exclusively limited to replacing the defective coated materials.
 4. Repairs that become necessary because of defective materials and workmanship while roof and wall panel system is under warranty are to be performed within 24 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

PART 2 - PRODUCTS

2.1 STRUCTURAL FRAMING MATERIALS

- A. Steel Shapes and Plates
 1. Wide flange and WT shapes: ASTM A992/A992M; ASTM A572/A572M or ASTM A529/A529M. Angles, Channels and Plates: ASTM A36/A36M, ASTM A572/A572M or ASTM A529/A529M. Provide structural steel shapes and plates containing a minimum of 80 percent recycled content. Submit data identifying percentage of recycled content for structural steel shapes and plates.
- B. Steel Pipe - Not Used
- C. Cold-Formed and Hot Formed Hollow Structural Sections
 1. Cold formed: ASTM A500/A500M or ASTM B221, ASTM B221M.
 2. Hot-formed: ASTM A501/A501M.

- D. Structural-Steel Sheet
 - 1. Hot-rolled, ASTM A1011/A1011M or cold-rolled, ASTM A1008/A1008M.
 - E. Metallic-Coated Steel Sheet ASTM
 - 1. A653/A653M, ASTM A606/A606M.
 - F. Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating
 - 1. Steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, and ASTM A123/A123M.]
 - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, and ASTM A463/A463M.]
 - G. Joist Girders – Refer to 051200 Structural Steel Framing
 - H. Steel Joist - Refer to 051200 Structural Steel Framing
 - I. High-Strength Bolts, Nuts, and Washers
 - 1. ASTM F3125/F3125M, heavy hex steel structural bolts; ASTM A563M ASTM A563 heavy hex carbon-steel nuts; and ASTM F436/F436M hardened carbon-steel washers.
 - a. Finish: Plain.
 - b. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, heavy-hex-head steel structural bolts with spline.
 - c. Finish: Plain.
 - J. Non-High-Strength Bolts, Nuts, and Washers
 - 1. ASTM A307, ASTM A563M ASTM A563, and ASTM F844.
 - a. Finish: Plain
 - K. Anchor Rods
 - 1. ASTM F1554] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].
 - a. Configuration: Straight.
 - b. Nuts: ASTM A563M ASTM A563 [heavy] hex carbon steel.
 - c. Plate Washers: ASTM A36/A36M carbon steel.
 - d. Washers: ASTM F436/F436M hardened carbon steel.
 - e. Finish: Plain.
 - L. Threaded Rods
 - 1. [ASTM A193/A193M] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].
 - a. Nuts: ASTM A563MASTM A563 [heavy] hex carbon steel.
 - b. Washers: [ASTM F436/F436M hardened] [ASTM A36/A36M] carbon steel.
 - c. Finish: Plain.
 - M. Primer
 - 1. SSPC-Paint 15, Type I, red oxide.
- 2.2 FABRICATION
- A. General
 - 1. Comply with MBMA MBSM - "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."
- 2.3 STRUCTURAL FRAMING
- A. General

1. Clean all framing members to remove loose rust and mill scale. Provide 1 shop coat of primer to an average dry film thickness of 1 mil according to SSPC SP 2. Balance of painting and coating procedures must conform to SSPC Paint 15 and SSPC Painting Manual.
- B. Primary Framing
1. Manufacturer's standard structural primary framing system includes transverse and lean-to frames; rafter, rakes, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing designed to withstand required loads and specified requirements. Provide frames with attachment plates, bearing plates, and splice members. Provide frame span and spacing indicated.
 2. Shop fabricate framing components by welding or by using high-strength bolts to the indicated size and section with base-plates, bearing plates, stiffeners, and other items required. Cut, form, punch, drill, and weld framing for bolted field erection.
 - a. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
 - b. Rigid Modular Frames - Not used
 - c. Frame Configuration: [Single gable], with high side connected to, and supported by, another structure] [Multiple gables]
 - d. Exterior Column Type: [Uniform depth]
 - e. Rafter Type: [Uniform depth]
- C. Secondary Framing
1. Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet pre-painted with coil coating, unless otherwise indicated.
 2. Shop fabricate framing components by roll-forming or break-forming to the indicated size and section with base-plates, bearing plates, stiffeners, and other plates required for erection. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
 - a. Purlins: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; minimum depth as required to comply with system performance requirements.
 - b. Girts: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange minimum depth as required to comply with system performance requirements.
 - c. Eave Struts: Unequal-flange, C-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.
 - d. Flange Bracing: Structural-steel angles or cold-formed structural tubing to stiffen primary frame flanges.
 - e. Sag Bracing: Structural-steel angles.
 - f. Base or Sill Angles: Zinc-coated (galvanized) steel sheet.
 - g. Purlin and Girt Clips: Steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
 - h. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from structural-steel sheet.
 - i. Framing for Openings: Channel shapes; fabricated cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb,

and sill of other openings.

- j. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

D. Bracing

1. Provide adjustable wind bracing as follows:

- a. Rods: ASTM A36/A36M; ASTM A572/A572M; or ASTM A529/A529M threaded full length at each end.
- b. Cable: ASTM A475, extra-high-strength grade, zinc-coated, with threaded end anchors.
- c. Angles: fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
- d. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
- e. Fixed-Base Columns: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
- g. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.
- h. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.

2.4 PANEL MATERIALS

A. Aluminum Sheet – Not Used

B. Steel Sheet – Refer to Section 053100 Steel Decking and Section 074113.16 Standing Seam Metal Roof Panels

1. Roll-form steel roof panels to the specified profile, with $f_y = 24$ gauge and depth as indicated. Steel sheets must contain a minimum recycled content of 25 percent. Provide data identifying percentage of recycled content for steel sheet materials. Material must be plumb and true, and within the tolerances listed:

- a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI D100.
- b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI D100.
- c. Individual panels to have continuous length to cover the entire length of any unbroken [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.
- d. Provide panels with thermal expansion and contraction consistent with the type of system specified;
 - profile to be a 2 inch high standing seam, 12 inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

C. Finish

1. All panels are to receive a factory-applied polyvinylidene fluoride of Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

- a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough

drying.

- b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.
- c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 0.05 mils for a total dry film thickness of 1.00 plus 0.10 mils. This finish coat must be oven-cured.
- d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.
- e. Color: The exterior finish chosen from the manufacturer's color charts and chips.
- f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:
 - Chalking: ASTM DEFONLINE
 - Color Change and Conformity: ASTM D2244
 - Weatherometer: ASTM G152, ASTM G153 and ASTM D822
 - Humidity: ASTM D2247 and ASTM D714
 - Salt Spray: ASTM B117
 - Chemical Pollution: ASTM D1308
 - Gloss at 60 degrees: ASTM D523
 - Pencil Hardness: ASTM D3363
 - Reverse Impact: ASTM D2794
 - Flexibility: ASTM D522/D522M
 - Abrasion: ASTM D968
 - Flame Spread: ASTM E84

2. Repair Of Finish Protection

3. Repair paint for enameled metal panel must be compatible paint of the same formula and color as the specified finish furnished by the metal panel manufacturer, conforming to ASTM A780/A780M.

2.5 MISCELLANEOUS METAL FRAMING

A. General

1. Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

B. Fasteners for Miscellaneous Metal Framing Refer to the following paragraph FASTENERS.

2.6 FASTENERS

A. General

1. Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 25.4 mm 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the metal panel manufacturer's and ASCE 7-16 requirements.

B. Exposed Fasteners

1. Fasteners for metal panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately .09 mm 3/32 inch thick.

C. Screws

1. Screws to be corrosion resistant coated steel, aluminum or stainless steel being the type and size

recommended by the manufacturer to meet the performance requirements.

- D. Rivets
 - 1. Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.
- E. Attachment Clips
 - 1. Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.7 FRAMES AND MATERIALS FOR OPENINGS

- A. Doors
 - 1. Fire-Rated and Non-Fire-Rated Door Assemblies conforming with NFPA 80 and based on testing according to NFPA 252 as specified in Division 08 - OPENINGS unless otherwise indicated.
- B. Windows
 - 1. Aluminum Window Assemblies conforming to AAMA/WDMA/CSA 101/I.S.2/A440 as specified in Division 08 - OPENINGS unless otherwise indicated.

2.8 ACCESSORIES

- A. General
 - 1. All accessories to be compatible with the metal panels; sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the metal panels. Exposed metal accessories/finishes to match the panels, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.
- B. Roof and Wall Accessories and Specialties
 - 1. Galvanized Steel roof curbs, equipment supports, roof hatches, dropout-type heat and smoke vents, hatch-type heat and smoke vents, gravity and roof ridge ventilators, wall louvers and other miscellaneous roof and wall equipment or penetrations conforming to AAMA, ASTM, and UL as specified in Division 07 unless otherwise indicated.
- C. Insulation – Refer to 072100 Thermal Insulation for more information.
 - 1. Faced, Glass-Fiber Blanket Insulation: ASTM C665, Type II, blankets with non-reflecting coverings, Class A, membrane-faced surface with a flame spread of 25 minimum and a smoke developed rating of 400 or less when tested in accordance with ASTM E84. Provide insulation materials containing the following minimum percentage of recycled content by weight: 20 percent glass cullet complying with ASTM D5359. Provide data identifying percentage of recycled content for insulation materials.
 - 2. Polyethylene Vapor Retarder
 - a. Install polyethylene vapor retarder membrane over entire [wall][and roof]surface. Use fully compatible polyethylene tape to seal the edges of the sheets to provide a vapor tight membrane. Lap sheets not less than 150 mm 6 inch. Provide sufficient material to avoid inducing stresses in sheets due to stretching or binding. All tears or punctures visible in the finished surface, at any time during the construction process, must be sealed with polyethylene tape.
 - 3. Wall Liner
 - a. Securely fasten wall liner into place in accordance with the manufacturer's recommendation and in a neatly presented appearance.
- D. Rubber Closure Strips
 - 1. Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified metal panel and in lengths supplied by the metal panel manufacturer.
- E. Metal Closure Strips

1. Factory fabricated closure strips to be the same material, thickness, color, finish and profile of the specified [roof] [wall] panel.

F. Joint Sealants

1. Sealants

- a. Sealants are to be an approved gun type for use in hand or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.
- b. Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the metal panel manufacturer.

2. Shop-Applied

- a. Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

3. Field-Applied

- a. See Section 07 92 00 JOINT SEALANTS for sealant requirements.

4. Tape Sealant

- a. Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the metal panel manufacturer.

2.9 SHEET METAL FLASHING AND TRIM

A. Fabrication

1. Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.
2. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.10 FINISHES

A. General

1. Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work

1. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before erection proceeds, examine with the erector present, the concrete foundation dimensions, concrete and masonry bearing surfaces, anchor bolt size and placement, survey slab elevation, locations of bearing plates, and other embedments to receive structural framing with the metal building manufacturer's templates and drawings before erecting any steel components for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine primary and secondary framing to verify that rafters, purlins, angles, channels, and other structural and metal panel support members and anchorages have been installed within alignment tolerances required by metal building manufacturer, UL, ASTM, ASCE 7-16 and as required by the building code for the geographical area where construction will take place.
- C. Examine roughing-in for components and systems penetrating metal roof or wall panels to verify actual

locations of penetrations relative to seam locations of metal panels before metal roof or wall panel installation.

- D. Submit to the Contracting Officer a written report, endorsed by Erector, listing conditions detrimental to performance of the Work.
- E. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shoring, guys, braces, and other supports during erection to keep the structural framing secure, plumb, and in alignment against temporary construction loading or loads equal in intensity of the building design loads. Remove temporary support systems when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.
- B. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment and performance.
- C. Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous support members or anchorage for the metal roof or wall panels, doors, windows, roof curbs, ventilators and louvers according to metal building manufacturer's written instructions.

3.3 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written erection instructions, approved shop drawings and other erection documents in accordance with MBMA MBSM - "Metal Building Systems Manual".
- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer and the Contracting Officer.
- C. Set structural framing accurately in locations and to elevations indicated and according to AISC 325 specifications. Maintain structural stability of frame during erection.
- D. Clean and roughen concrete and masonry bearing surfaces prior to setting plates. Clean bottom surface of plates.
- E. Align and adjust structural framing before permanent bolt-up and connections. Perform necessary adjustments and alignment to compensate for changes or discrepancies in elevations.
- F. Maintain erection tolerances of structural framing in accordance with AISC 360.

3.4 ROOF PANEL INSTALLATION

- A. Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the Work securely in place in accordance with NRCA RoofMan and MBMA MBSM.
- B. Erect roofing system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.
- C. Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.
- D. Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake and eave overhang.
- E. Work must allow for thermal movement of the roofing, movement of the building structure, and provide permanent freedom from noise due to wind pressure.
- F. Field cutting metal roof panels by torch is not permitted.

- G. Do not permit storage, walking, wheeling, or trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials, and to distribute weight to conform to the indicated live load limits of roof construction.

3.5 METAL PANEL FASTENER INSTALLATION

- A. Anchor metal panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.6 FLASHING, TRIM AND CLOSURE INSTALLATION

- A. Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

3.7 DOOR AND FRAME INSTALLATION

- A. Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each door frame with elastomeric sealant compatible with metal panels. Comply with installation requirements in Division 08 - OPENINGS.

3.8 WINDOW INSTALLATION

- A. Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each window frame with elastomeric sealant compatible with for metal panels. Comply with installation requirements in Division 08 - OPENINGS.

3.9 ACCESSORY INSTALLATION

- A. General
 - 1. Install accessories with positive anchorage to building and weather-tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
- B. Dissimilar Metals
 - 1. Where dissimilar metals contact one another or corrosive substrates are present, protect against galvanic action by painting dissimilar metal surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each surface, or by other permanent separation techniques as recommended by the metal building manufacturer.
- C. Gutters and Downspouts
 - 1. Comply with performance requirements, manufacturer's written installation instructions, and install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA 1793 recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
- D. Insulation
 - 1. Comply with performance requirements and manufacturer's written installation instructions. Install insulation concurrently with metal panel installation, in thickness indicated to cover entire roof and wall area, as specified in Division 07 - THERMAL AND MOISTURE PROTECTION.

E. Roof and Wall Accessories and Specialties

1. Install roof and wall accessories and specialties complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports as specified in Division 07 - THERMAL AND MOISTURE PROTECTION, unless otherwise indicated.

3.10 CLEAN-UP AND PROTECTION

A. Structural Framing

1. Clean all exposed structural framing at completion of installation. Remove metal shavings, filings, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

B. Metal Panels

1. Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove protective coverings/films, grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

C. Touch-Up Painting

1. After erection, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories. Clean and touch-up paint [with manufacturer's touch-up paint]

3.11 WASTE MANAGEMENT

- A. Dispose of construction waste in accordance with the requirements of Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

End of Section 133419

SECTION 211313 – WET PIPE SPRINKLER SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 PROJECT SCOPE

- A. The Contractor shall be responsible for providing a new wet-pipe sprinkler system including all design and calculations, materials, labor, transportation, supervision, certification, sprinkler heads, risers, piping, valves, and accessories needed for a complete and functional system. New system shall be installed as part of the new Fire Station addition and shall cover all all areas as required by NFPA and UFC 3-600-01. The Contractor shall be responsible for submitting for approval a complete design signed and prepared by a qualified Fire Protection Engineer (QFPE) showing all initial riser diagrams, calculations, head quantity and location, and shall be involved through the life of the sprinkler system installation. The Contractor shall be responsible for final inspections, testing requirements, and final certifications.

1.3 SUMMARY

- A. This section is applicable to the expansion of the existing wet pipe fire sprinkler system.
- B. This section applies to the system starting at the control valve at the bottom of the wet pipe riser and includes all downstream piping and equipment.

1.4 DEFINITIONS

- A. Contractor: The Texas state licensed fire sprinkler company who is awarded this project.
- B. Technician: An individual who has achieved NICET Level III or IV certification in Water-Based Fire Suppression Systems Layout and who has the knowledge, experience, and skills necessary to layout fire protection systems. The Technician shall be an employee of the Contractor. The Technician shall supervise or perform all submittals, installation, and testing indicated in this specification section.
- C. Qualified Fire Protection Engineer (QFPE): An individual who is a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. For this particular project, the QFPE is the fire protection Engineer of Record.

1.5 SUBMITTALS

- A. General: All submittals shall be developed or immediately supervised by the Technician. The QFPE Fire Protection of record, shall review all submittals through construction administration; prior to submittal to the government. The submittals are only required to be developed to reflect the project scope of work.
- B. Format: Unless noted otherwise below, all submittals shall be provided electronically in .PDF file format. Each file name shall clearly identify its contents. Where multiple submittals are combined into one file, electronic bookmarks shall be provided which clearly indicate its contents. Drawings, product data, calculation, and test report files shall be generated using software, not a scanner. Submittals not complying with these requirements will be immediately rejected.
- C. Sequence:
 - 1. Each submittal indicated below shall first be submitted for review to the QFPE. Upon approval by the QFPE, the Technician shall forward the submittals necessary for permitting to the authority having jurisdiction (AHJ).

- 2 The following submittals shall all be submitted together in one complete package: Qualifications, Product Data, Shop Drawings, Water Delivery Time Calculations, Hydraulic Calculations, and Hydrant Flow Test. 'Piece-mealed' submittals will be immediately rejected.
- D. Qualification Data: Submit qualifications for Technician.
 - E. Product Data: Submit product data for each system component required to be listed by NFPA 13. Model, size, orientation, finish, and other options shall be clearly indicated for each product.
 - F. Shop Drawings: Comply with NFPA 13 Chapter 22 Plans and Calculations. Drawings shall comply with Working Plan requirements of NFPA 13 Section 22.1.
 - G. Hydraulic Calculations: Comply with NFPA 13 Chapter 23 Plans and Calculations.
 - H. Hydrant flow test results: The Contractor's confirming hydrant flow test shall be documented to confirm compliance with NFPA 291. This shall include the location, date, and time of the test; number, size, and coefficient of outlets; static and residual pressures; and flow measurements. Gauges shall be calibrated within the last 6 months.
 - I. Acceptance Test Notice: The Technician shall submit written request to schedule system acceptance testing at least 14 days prior to scheduled testing. This request shall be submitted to the QFPE and the AHJ. Acceptance test results will not be considered unless the tests are witnessed by the QFPE and the AHJ. The written request shall include a statement which verifies that the updated as-built drawings will be available at the scheduled acceptance test.
 - J. Acceptance Test Reports: The Technician shall complete the *Contractor's Material and Test Certificate for Aboveground Piping* provided in NFPA 13. This certificate shall be submitted to the QFPE for review no later than 7 days after the completion of the acceptance testing.
 - K. Record Drawing Red-Lines: The Technician shall clearly indicate any revisions to the bid documents in red. This submittal shall be provided no later than 14 days after completion of final acceptance testing.
 - L. As-Built Drawings: The Technician shall maintain at least one set of approved shop drawings with all field changes clearly annotated. The as-built drawings shall be accurate within +/- 6 inches. The as-built drawings shall be available during final acceptance testing for review by the QFPE. Upon project completion, the Technician shall submit the shop drawings with all red-lines incorporated into the AutoCAD files. The as-built drawings shall be submitted in both .PDF and .DWG format.
 - M. Operation and Maintenance Manual: The Technician shall assemble an O&M Manual which consists of: table of contents, warranty statement, parts list, service company contact information, 11"x17" as-built drawings, approved product data, acceptance test reports, maintenance intervals, and troubleshooting process for typical system malfunctions. Other than drawings, all pages shall be 8.5"x11" and shall be bound by a durable binding method (3-ring binder, for example), and shall be clearly labeled and organized.
- 1.6 GENERAL SYSTEM REQUIREMENTS
- A. All submittals, products, installation, and testing shall comply with UFC 3-600-01 and NFPA 13, "Installation of Sprinkler Systems", 2016 Edition, except where modified by this specification section and the contract drawings.
 - B. All aboveground piping and components shall be listed for a minimum 175 psig working pressure.
 - C. Seismic Performance: Seismic bracing is not required since the seismic design category is "A."
 - D. Welding: If welding is required, it shall be in accordance with NFPA 13 section 6.5.2 (fabrication, fittings, methods, qualifications, and documentation).

1.7 QUALITY ASSURANCE

- A. The Technician shall visit the project site, at least periodically (not less than two site visits per month), to ensure the system is being installed in accordance with the approved submittals. Upon request, the Technician shall be able to provide documentation of site visits.
- B. Installers shall have been regularly engaged in projects of similar scope and complexity for at least 2 months prior to the award of this contract. Upon request, documentation of their experience shall be available.
- C. Electrical Components, Devices, and Accessories: All system electrical components (local waterflow horn/strobe, for example) shall be listed and labeled as defined in NFPA 72 and NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.8 COORDINATION

- A. The Technician shall ensure the sprinkler system layout is coordinated with all other trades.

1.9 WARRANTY

- A. Contractor shall provide a warranty for all system failures as a result of manufacturing, installation, or workmanship. The warranty period shall be one year from the date of beneficial occupancy (established by QFPE). Include the warranty statement in the O&M manual.
- B. Warranty claims which are necessary for proper system operation shall be responded to, and their repair scheduled, within 24 hours of warranty claim (the actual time allowed for the repair work shall be negotiated with the building owner at the time of warranty claim).
- C. Warranty claims which are not necessary for proper system operation shall be responded to, and their repair scheduled, within one week of warranty claim (the actual time allowed for the repair work shall be negotiated with the building owner at the time of warranty claim).

1.10 EXTRA MATERIALS

- A. Sprinkler cabinets: Factory applied red finish, wall-mounted, steel cabinet with hinged cover. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Cabinet shall be labeled "SPARE SPRINKLERS."

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products permitted by UFC 3-600-01 and NFPA 13 are acceptable, except where modified by this specification section.

2.2 SPRINKLERS

- A. Upright sprinklers shall be provided with brass finish.
- B. Pendent sprinklers shall be recessed with flush-type escutcheons or concealed sprinklers and shall be part of a listed sprinkler assembly. Cover plates used with concealed sprinklers shall be part of the listed sprinkler assembly. The use of caulking or glue to seal the penetration or to affix the components of a recessed escutcheon or concealed cover plate shall not be permitted.

- C. All sprinklers shall be intermediate temperature except where proximity to a heat source requires higher temperature sprinklers in accordance with NFPA 13.

2.3 ABOVEGROUND PIPING

- A. Comply with requirements of UFC 3-600-01 and NFPA 13 for aboveground piping.
- B. Aboveground piping shall be schedule 40 black steel for sizes 2-inch and less. Aboveground piping 2.5- inches and larger shall be at least schedule 10 black steel.
- C. Steel piping with wall thickness less than schedule 40 shall not be threaded.
- D. All aboveground components shall be listed for 175-psig minimum working pressure.

2.4 VALVES

- A. All isolating control valves larger than 2-inches shall be butterfly valves with integral tamper switches and shall have resilient seating wedges.
- B. Check valves shall be the swing-type.

2.5 HYDRAULIC DATA PLACARD

- A. Install a new hydraulic data placard to indicate the hydraulic data for the new wet pipe sprinkler system.
- B. The hydraulic data placard shall be steel.
- C. Hydraulic design information shall be stamped into the data placard.
- D. Written (ink) design information is prohibited.

2.6 PROHIBITED PRODUCTS

- A. Sprinklers which utilize an O-ring water seal are prohibited.
- B. Plain end fittings with mechanical couplings and fittings that use steel gripping devices to bite into the pipe are prohibited.
- C. Reducing couplings are prohibited.
- D. Side outlet mechanical tees using rubber gasket fittings are prohibited in new construction.

2.7 ADDITIONAL REQUIREMENTS

- A. Double check or reduced pressure type backflow protection shall be installed as part of the fire protection system. Post Indicator Valves (PIV) shall be installed with an electronic tamper proof switch, physical locks, and a permanently attached 6"x4" brown sign with white text identifying the building or buildings served. OS & Y valves shall have a dual tamper switch located on valves. The PIV shall be painted to match the color currently used on Goodfellow AFB.
- B. Fire protection piping under buildings shall be ductile iron to a point 5 ft. outside the building. Ductile iron fire protection risers and fire hydrant hubs shall be provided with a sacrificial anode to conform to UFC 3-570-06 and MIL HDBK 1136.
- C. Sprinkler Heads: Semi-recessed or fully recessed sprinkler heads shall be used to the greatest extent possible. All sprinkler conduit shall be black steel pipe IAW NFPA 13.

PART 3 - EXECUTION

3.1 GENERAL

- A. All materials shall be stored, installed, and tested in accordance with NFPA 13 and the manufacturer's instructions.
- B. All system components shall be installed in a neat, workmanlike manner. Installation shall be straight and true with building structure.

3.2 CONSTRUCTION SEQUENCE

- A. Coordinate construction sequence with owner.
- B. Commissioning of the updated existing sprinkler system shall be done when the facility is normally unoccupied.

3.3 SPRINKLER INSTALLATION

- A. Where sprinklers are installed 7 ft or less above finished floor, or otherwise subject to mechanical damage, the sprinklers shall be provided with listed guards.

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1 (no more than four threads shall be visible when joint is fully made-up). Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads (male only threads).
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 FIRESTOPPING

- A. Where piping penetrates a fire-resistance rated wall, the Contractor shall protect the penetration with a listed firestopping assembly. A permanent label shall be provided on the wall adjacent to the penetration identifying the listed firestopping assembly, penetrating item, date of installation, and initials of installer.

3.6 CLEANING

- A. Clean dirt and debris from all valves, riser, and all riser components.

3.7 SYSTEM ACCEPTANCE

- A. The Contractor shall perform all acceptance tests required by NFPA 13 and the manufacturer's recommendations and shall document tests on standard NFPA

completion forms. Modifications to existing piping systems shall require testing at system working pressure.

- B. The Contractor shall provide all labor, tools, and equipment necessary to conduct all acceptance tests required by NFPA 13.
- C. The Contractor shall notify the Facility Owner, Fire Protection Offices, CE Alarm Technicians, CE Plumbers, QFPE, and AHJ at least two weeks prior to tests so that they can be witnessed by the necessary personnel.
- D. The Contractor shall provide updated as-built drawings at the final acceptance test. These drawings shall have all changes electronically incorporated. Field mark-ups will not be considered adequate.

END OF SECTION 21 13 13

SECTION 22 00 00 - PLUMBING GENERAL PURPOSE

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 within the text by the basic designation only. The latest edition of the publications at the date of solicitation shall be used.

1. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-
CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP Energy Standard for Buildings Except
Low-Rise Residential Buildings

2. AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001 Performance
Requirements
For Atmospheric
Type Vacuum Breakers

ASSE 1010 Performance Requirements for
Water Hammer Arresters

ASSE 1012 Performance Requirements
for Backflow Preventer with an
Intermediate
Atmospheric Vent

ASSE 1013 Performance Requirements for
Reduced Pressure Principal
Backflow Preventers and Reduced
Pressure Fire Protection Principal
Backflow Preventers

ASSE 1018 Performance Requirements for
Trap Seal Primer Valves -
Potable Water Supplied

ASSE 1019 Performance Requirements for
Wall Hydrant with Backflow
Protection and Freeze
Resistance

3. AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300 Hypochlorites

AWWA B301 Liquid Chlorine

AWWA C651 Standard for Disinfecting
Water Mains

4. AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M

Specification for Filler Metals for
Brazing and Braze Welding

AWS B2.2/B2.2M

Specification for Brazing Procedure
and Performance Qualification

5. ASME INTERNATIONAL (ASME)

ASME A112.1.2

Air Gaps in Plumbing
Systems (For Plumbing
Fixtures and Water-
Connected Receptors)

ASME A112.14.1

Backwater Valves

ASME B1.20.1

Pipe Threads, General Purpose (Inch)

ASME B16.12

Cast Iron Threaded Drainage
Fittings

ASME B16.15

Cast Copper Alloy Threaded
Fittings Classes 125 and 250

ASME B16.18

Cast Copper Alloy Solder
Joint Pressure Fittings

ASME B16.21

Nonmetallic Flat Gaskets for
Pipe Flanges

ASME B16.22

Standard for Wrought Copper and
Copper Alloy Solder Joint Pressure
Fittings

ASME B16.23

Cast Copper Alloy Solder
Joint Drainage Fittings -
DWV

ASME B16.24

Cast Copper Alloy Pipe Flanges
and Flanged Fittings: Classes
150, 300, 600,
900, 1500, and 2500

ASME B16.29

Wrought Copper and Wrought
Copper Alloy Solder Joint Drainage
Fittings - DWV

ASME B16.3

Malleable Iron Threaded
Fittings, Classes 150 and 300

ASME B16.34

Valves - Flanged,
Threaded and Welding End

ASME B16.4

Standard for Gray Iron
Threaded Fittings; Classes
125 and 250

ASME B16.5

Pipe Flanges and Flanged Fittings
NPS 1/2 Through NPS 24
Metric/Inch Standard

ASME B16.50	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B31.1	Power Piping
ASME B31.5	Refrigeration Piping and Heat Transfer Components
ASME B40.100	Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	BPVC Section IX-Welding and Brazing Qualifications
6. ASTM INTERNATIONAL (ASTM)	
ASTM A105/A105M	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A183	Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A47/A47M	Standard Specification for Ferritic Malleable Iron Castings
ASTM A515/A515M	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A74	Standard Specification for Cast Iron Soil Pipe and Fittings

ASTM A888	Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B306	Standard Specification for Copper Drainage Tube (DWV)
ASTM B32	Standard Specification for Solder Metal
ASTM B42	Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B75/B75M	Standard Specification for Seamless Copper Tube
ASTM B813	Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B88	Standard Specification for Seamless Copper Water Tube
ASTM C564	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

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| ASTM D3311 | Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns |
| ASTM E1 | Standard Specification for ASTM Liquid-in-Glass Thermometers |
| ASTM F477 | Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F1807 | Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing |
| ASTM F891 | Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems |
| 7. CAST IRON SOIL PIPE INSTITUTE (CISPI) | |
| CISPI 301 | Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| CISPI 310 | Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| 8. COPPER DEVELOPMENT ASSOCIATION (CDA) | |
| CDA A4015 | Copper Tube Handbook |
| 9. INTERNATIONAL CODE COUNCIL (ICC) | |
| ICC IPC | International Plumbing Code |
| 10. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS) | |
| MSS SP-110 | Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| MSS SP-25 | Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | Pipe Hangers and Supports - Materials, Design and |

	Manufacture, Application, and Installation	Selection, and Installation
MSS SP-67	Butterfly Valves	
MSS SP-70	Gray Iron Gate Valves, Flanged and Threaded Ends	
MSS SP-71	Gray Iron Swing Check Valves, Flanged and Threaded Ends	
MSS SP-72	Ball Valves with Flanged or Butt-Welding Ends for General Service	
MSS SP-78	Cast Iron Plug Valves, Flanged and Threaded Ends	
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves	
MSS SP-85	Gray Iron Globe & Angle Valves Flanged and Threaded Ends	
11.	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA MG 1	Motors and Generators	
NEMA MG 11	Energy Management Guide for Selection and Use of Single Phase Motors	
12.	NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems	
13.	NSF INTERNATIONAL (NSF)	
NSF 372	Drinking Water System Components - Lead Content	
NSF/ANSI 61	Drinking Water System Components - Health Effects	
14.	PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)	
PPFA Fire Man	Firestopping: Plastic Pipe in Fire Resistive Construction	
15.	PLUMBING AND DRAINAGE INSTITUTE (PDI)	
PDI WH 201	Water Hammer Arresters Standard	
16.	U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)	

EPA SM 9223

Enzyme Substrate Coliform Test

PL 93-523

Safe Drinking Water Act

17. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 141.80

National Primary Drinking Water
Regulations; Control of Lead
and Copper; General
Requirements

PL 109-58

Energy Policy Act of 2005 (EPAct05)

1.2 SUBMITTALS

- A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01010 PARAGRAPH 16 - SUBMITTAL REQUIREMENTS:
- B. SD-03 Product Data
 - 1. List of installed fixtures with manufacturer, model, and flow rate:
 - 2. Pumps; G
 - 3. Backflow Prevention
Assemblies; G
 - 4. Vibration-Absorbing Features: Details of vibration-absorbing features, including arrangement, foundation plan, dimensions, and specifications; G
 - 5. Energy-Efficient Water
Heater; G
 - 6. Water Closet; G
 - 7. ADA Compliant Water Closet;
G
 - 8. Water Closet Flush Valve; G
 - 9. Urinal; G
 - 10. ADA Compliant Urinal; G
 - 11. Urinal Flush Valve; G
 - 12. Lavatory; G
 - 13. Lavatory Faucet; G
 - 14. Shower Assembly; G
 - 15. Mop Sink; G
 - 16. Mop Sink Faucet Assembly; G
 - 17. Thermostatic Mixing Valve; G
 - 18. Electric Water Cooler W/
Bottle; G
- C. SD-06 Test Reports
 - 1. Tests, Flushing and Disinfection; G
 - 2. Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test

report shall indicate the final position of controls.

3. Test of Backflow Prevention Assemblies; G.
 4. Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.
- D. SD-10 Operation and Maintenance
1. Data Plumbing System; G
- E. SD-11 Closeout Submittals
1. Pass Through Warranties shall be submitted for the following products:
 2. Pumps
 3. Backflow Prevention
Assemblies
 4. Vibration-Absorbing Features
 5. Energy-Efficient Water Heater
 6. Water Closet
 7. ADA Compliant Water Closet
 8. Water Closet Flush Valve
 9. Urinal
 10. ADA Compliant Urinal
 11. Urinal Flush Valve
 12. Lavatory
 13. Lavatory Faucet
 14. Shower Assembly
 15. Mop Sink
 16. Mop Sink Faucet Assembly
 17. Thermostatic Mixing Valve
 18. Electric Water Cooler W/
Bottle

1.3 STANDARD PRODUCTS

- A. Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

1. Alternative Qualifications

- a. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

2. Service Support

- a. The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

3. Manufacturer's Nameplate

- a. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

4. Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

a. Definitions

- For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

b. Administrative Interpretations

- For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition

Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Contractor shall Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

- A. Welding
 - 1. Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVCSEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.6 REGULATORY REQUIREMENTS

- A. Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1 – IP.

1.7 PROJECT/SITE CONDITIONS

- A. The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

- A. When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.
- B. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.
- C. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY OF EQUIPMENT

- A. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors/panels.

PART 2 - PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

A. Water-Efficient Products

- 1. Provide documentation that the following product(s) meet water efficiency requirements as outlined in this section and when applicable, that they are EPA WaterSense labeled products:
 - a. Pumps
 - b. Water Closets
 - c. Water Closet Flush Valves
 - d. Urinals
 - e. Urinal Flush Valves
 - f. Lavatory Faucet
 - g. Shower Assembly
 - h. Mop Sink Faucet Assembly

2.2 Materials and Equipment

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for service intended. Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size and shall comply with NSF/ANSI 14, NSF/ANSI 61 and ASTM F 2389. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment used in any potable water system intended for human consumption shall comply with the Safe Drinking Water Act (SDWA) and shall be certified in accordance with NSF/ANSI 61 Annex G or NSF 372. In line devices including, but not limited to: water meters, building valves, check valves, meter stops, valves, fittings, and back flow prevention assemblies shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices including, but not limited to: lavatory faucets, shower assemblies, mop sink faucets, electric water cooler, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums.

A. Piping

- 1. New domestic cold and hot water piping must be PEX-B with ASTM F1807 brass crimp type fittings and applicable diameter x 6 inch copper stub outs with pre-drilled mounting ears/copper pipe support brackets.

B. Pipe Joint Materials

- 1. Grooved pipe and hubless cast-iron soil pipe shall not be used underground.

Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310
- b. Coupling for Steel Pipe: AWWA C606.
- c. Couplings for Grooved Pipe: Ductile Iron ASTM A536 (Grade 65-45-12).
Copper ASTM A536.
- d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self-centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
- e. Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.
- f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
- g. Solder Material: Solder metal shall conform to ASTM B32.
- h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.
- i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.
- j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.
- k. Rubber Gaskets for Grooved Pipe: ASTM D2000, maximum temperature 230 degrees F.
- l. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.
- m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.
- n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.
- o. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.
- p. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.
- q. Flanged fittings including, but not limited to, flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A15/A15M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M.

- r. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.
- s. Press fittings for Copper Pipe and Tube: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for copper press fittings shall be EPDM, FKM or HNBR. Sealing elements shall be factory installed or an alternative supplied fitting manufacturer. Sealing element shall be selected based on manufacturer's approved application guidelines.
- t. Copper tubing shall conform to ASTM B88, Type K, L or M.

C. Miscellaneous Materials

- 1. Miscellaneous materials shall conform to the following:
 - a. Water Hammer Arrester: PDI WH 201. Water hammer arrester shall be diaphragm type or piston type.
 - b. Copper, Sheet and Strip for Building Construction: ASTM B370.
 - c. Asphalt Roof Cement: ASTM D2822/D2822M.
 - d. Hose Clamps: SAE J11508.
 - e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
 - f. Metallic Cleanouts: ASME A1112.36.2M.
 - g. Plumbing Fixtures Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
 - h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.
 - i. Hypochlorites: AWWA 300.
 - j. Liquid Chlorine: AWWA B301.
 - k. Gauges – Pressure and Vacuum Indicating Dial Type – Elastic Elemtn: ASME B40.100.
 - l. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

D. Pipe Insulation Material

- 1. Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.3 PIPE HANGERS, INSERTS, AND SUPPORTS

- A. Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.4 VALVES

- A. Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application.

Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003
Water heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Portable-Water Heaters Bottom Drain Valve
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

B. Hose Bibbs

1. Hose Bibbs shall be ¼ turn ball valve type, have a vacuum-breaker backflow preventer and be brass with 3/4 inch male inlet threads. Hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

C. Wall Hydrants (Frostproof)

1. ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 20 mm 3/4 inch exposed hose thread on spout and 20 mm 3/4 inch male pipe thread on inlet.

D. Relief Valves

1. Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

E. Thermostatic Mixing Valves

1. Provide thermostatic mixing valve for lavatory faucets. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees Fahrenheit of any setting.

F. Backwater Valves

1. Backwater valves shall be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Valves shall have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves shall be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats shall be nonferrous metal. Disks shall be slightly open in a no-flow no-backwater condition. Cleanouts shall extend to

finished floor and be fitted with threaded countersunk plugs.

2.5 FIXTURES

- A. Fixtures shall be water conservation type, in accordance with ICC IPC. Fixtures for Use by the physically handicapped shall be in accordance with ICC/ANSI A117.1. Porcelain fixtures shall be Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.
- B. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipes, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years.
- C. Automatic Controls
1. Flushing and faucet systems shall be manual type. No automatic controls will be allowed.
- D. Flush Valve Water Closets
1. ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, elongated bowl, wall mounted, wall outlet. Top of toilet seat height above floor shall be 14 to 15 inches, except 17 to 19 inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve. Provide white solid plastic elongated open-front seat.
 2. Water flushing volume of the water closet and flush valve combination shall not exceed 1.1 gallons per flush.
 3. Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture. Mounted height of flush valve shall not interfere with the handrail in ADA stalls.
- E. Flush Valve Urinals
1. ASME A113.19.2/CSA B45.1, white vitreous china, wall-mounted, wall outlet, blowout action, integral trap, elongated projecting bowl, 20 inches long from wall to front of flare, and ASME A112.19.5 trim. Provide large diaphragm (not less than 2.625 inches upper chamber inside diameter at the point where diaphragm is sealed between the upper and lower chambers), nonhold-open flush valve of chrome plated cast brass conforming to ASTM B584, including vacuum breaker and angle (control-stop) valve with back check.
 2. The water flushing volume of the flush valve and urinal combination shall not exceed 0.5 gallons per flush.
 3. Provide ASME A112.6.1M concealed chair carriers. Mount urinal with front

rim a maximum of 17 inches above floor and flush valve handle a maximum of 44 inches above floor for use by handicapped on wheelchair.

F. Countertop Lavatories

1. ASME A112.19.2/CSA B45.1, white vitreous china, self-rimming, minimum dimensions as shown on the Architectural drawings, with supply openings for use with top mounted centerset Tests. Furnish template and mounting kit by lavatory manufacturer. Provide aerator with faucet. Water flow rate shall be as stated on the drawings and measured at a flowing water pressure of 60 psi. Provide top mounted washerless centerset lavatory faucets.

G. Drinking-Water Coolers

1. ABA compliant, bi-level, AHRI 1010 compliant with more than a single thickness of metal between the potable water and the refrigerant in the heat exchanger, wall-hung, bubbler style, air-cooled condensing unit, 4.75 gph minimum capacity, stainless steel splash receptor and basin, bottle filler and stainless steel cabinet. Bubblers shall be controlled by push levers or push bars, front mounted or side mounted near the front edge of the cabinet. Bubbler spouts shall be mounted at maximum of 36 inches above floor and at front of unit basin. Spouts shall direct water flow at least 4 inches above unit basin and trajectory parallel or nearly parallel to the front of unit. Provide ASME A112.6.1M concealed steel pipe chair carriers.

H. Mop Sinks

1. Provide 24" x 24" x 10" tall molded high density composite basin, PVC drain body, stainless steel strainer and 3" gasketed outlet connect. hose, hose bracket, mop hangar and fiberglass resin panel back splash on the two long sides.

I. Showers

Shower faucet and appurtenances.

1. Faucet: Single-handle, thermostatic mixing valve with hot and cold water indicators; check stops; and shower head:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Materials: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Maximum Flow Rate: 1.5 gpm unless otherwise indicated.
 - e. Mounting: Concealed.
 - f. Operation: Single-handle, push-pull or twist or rotate control.
 - g. Antiscald Device: Integral with mixing valve.
 - h. Check Stops: Check-valve type, integral with or attached to body; on hot and cold water supply connections.
2. Outlet: Drain with NPS 2 outlet.
3. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Tamper-Resistant.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: Fixed.
 - e. Integral Volume Control: Required.
4. Provide fittings for PEX tubing

2.6 BACKFLOW PREVENTERS

- A. Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow

prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies.

- B. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be meet the above requirements.
- C. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principal backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.
- D. Ensure that backflow prevention devices are aboveground, accessible and testable.

2.7 DRAINS

A. Floor, Sink and Shower Drains

- 1. Floor, sink and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed provided that the drain is specifically designed for the rubber gasket compression type joint. Floor, sink and shower drains shall conform to ASME A112.6.3. Provide drains with trap primer connection, trap primer, and connection piping. Primer shall meet ASSE 1018.

B. Drains

- 1. Drains installed in connection with waterproofed floors shall be equipped with bolted-type device to securely clamp flashing.

2.8 SHOWER PAN

A. Shower pan may be nonmetallic material.

B. Solid Surface Shower Receptor

- 1. Shower receptor shall conform to ANSI 124.1.2-2005. The solid surface shall not support fungal and bacterial growth as testing in accordance with ASTM G-21 and ASTM G-22. The receptor floor shall be solid cast product with integral threshold and water barrier.

2.9 TRAPS

- A. Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel. Taps shall be without a cleanout. Tubes shall be copper alloy with

walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint. Traps in exposed locations shall be chrome plated.

2.10 WATER HEATER

- A. Water heater types and capacities shall be as indicated in drawings. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees Fahrenheit. Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 120 to 180 degrees Fahrenheit. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees Fahrenheit water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated.
- B. Automatic Storage Type
1. Heaters shall be complete with control system and shall have ASME rated combination pressure and temperature relief valve.
 - a. Gas-Fired Type
 - Gas-fired water heaters shall conform to ANSI Z21.10.1/CSA 4.1 when input is 75,000 BTU per hour or less or ANSI Z21.10.3/CSA 4.3 for heaters with input greater than 75,000 BTU per hour.

2.11 PUMPS

- A. Circulating Pumps
1. Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze.
 2. Motor shall be totally enclosed, fan-cooled or open drip proof depending on location installed and shall have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover.

B. Flexible Connectors

1. Flexible connector shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

2.12 DOMESTIC WATER-SERVICE METER

- A. Reference 331100 Water Utility Distribution Piping.
- B. Provide water meters to monitor use in building consuming indoor and outdoor water as required by DODI 4170.11 (Installation Energy Management). Implement sub-metering when authorized in writing by the installation. Refer to ASHRAE 189.1 Section 7.3.3 (Energy Consumption Management) for subsystem implementation.
- C. Meters must be connected to the base wide energy and utility monitoring and control system (if this system exists) using the installation's advanced metering protocols.

2.13 ELECTRICAL WORK

- A. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.
- B. Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.
- C. Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.
- D. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements as specified and in the drawings.

2.14 MISCELLANEOUS PIPING ITEMS

- A. Escutcheon Plates
 1. Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.
- B. Pipe Sleeves
 1. Provide where piping passes entirely through walls, ceilings, roofs, and floors.

Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

2. Sleeves in Masonry and Concrete
 - a. Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.
 3. Sleeves Not in Masonry and Concrete
 - a. Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.
- C. Pipe Hangers (Supports)
1. Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.
- D. Nameplates
1. Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A full port ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

- A. Water Pipe, Fittings, and Connections

1. Utilities

- The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

2. Cutting and Repairing

- The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3. Protection of Fixtures, Materials, and Equipment

- Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

4. Mains, Branches, and Runouts

- Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

5. Pipe Drains

- Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

6. Expansion and Contraction of Piping

- Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets and changes in direction where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

7. Commercial-Type Water Hammer Arresters

- Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDIWH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

8. PEX Tubing Installation

- a. Carefully examine the PEX tubing for defects, cuts, abrasions, cracks, fading color, or blemishes. There shall be no cracks or heavy deformations of the tubing. Fittings and manifolds shall be checked for any signs of abuse. Any damaged tubing or fittings shall be rejected. Cross-linked Polyethylene tubing shall be cut with a PEX tubing cutter. The tubing shall be cut squarely and neatly to permit a proper connection between the tubing and fitting.

PEX tubing shall not exceed an eight times the tubing outside diameter (OD) free bend radius or a five times the tubing OD supported bend radius, with use of a Viega approved bend support. Install fittings for changes in direction where any minimum bend radius is exceeded and branch connections.

PEX Crimp fittings shall be made in accordance with the manufacturer's installation instructions.

Provide allowance for thermal expansion and contraction of PEX tubing passing through a wall, floor, ceiling or partition by wrapping with pipe insulation, or by installing through an appropriately sized sleeve. Penetrations of fire resistance rated assemblies shall maintain the rating of the assembly.

PEX tubing must be supported every 32" horizontally with manufacturer's approved suspension clips or plastic insulators. Vertical PEX tubing must be supported at each floor or ceiling penetration and every four feet in between.

B. Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

1. Threaded

- Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

2. Mechanical Couplings

- Mechanical couplings may be used in conjunction with grooved pipe for aboveground, ferrous or non-ferrous, domestic hot and cold water systems, in lieu of unions, brazed, soldered, welded, flanged, or threaded joints.
- Mechanical couplings are permitted in accessible locations including behind access plates. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to ensure positive rigid clamping of the pipe.
- Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications will not be permitted.
- Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations.
- The Contracting Officer shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and to verify the groove dimensions in accordance with the coupling manufacturer's specifications.

3. Unions and Flanges

- Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

4. Grooved Mechanical Joints

- Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-

go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

5. Cast Iron Soil, Waste and Vent Pipe

- Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

6. Copper Tube and Pipe

- Brazed: Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
- Soldered: Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.
- Copper Tube Extracted Joint: Mechanically extracted joints shall be made in accordance with ICC IPC.
- Press connection: Copper press connections shall be made in **strict** accordance with the manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the manufacturer **of that joint**. Minimum distance between fittings shall be in accordance with the manufacturer's requirements.

7. Plastic Pipe

- Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed) or mated flanged.

C. Dissimilar Pipe Materials

1. Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

D. Corrosion Protection for Buried Pipe and Fittings

1. Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Coatings shall be selected, applied, and inspected in accordance with NACE SP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

E. Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

1. Sleeve Requirements

- Unless indicated otherwise, provide pipe sleeves meeting the following requirements:
- Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.
- A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber seal elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.
- Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.
- Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.
- Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C920 and with a primer,

backstopmaterial and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

- Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

2. Flashing Requirements

- Pipes passing through roof shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3. Waterproofing

- Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floors membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

4. Optional Counterflashing

- Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

A standard roof coupling for threaded pipe up to 6 inches in diameter.

A tack-welded or banded-metal rain shield around the pipe.

5. Pipe Penetrations of Slab on Grade Floors

- Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS and WATERPROOFING, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINTSEALANTS.

6. Pipe Penetrations

- Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

F. Fire Seal

1. Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

G. Supports

1. General

- a. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

2. Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-58 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher.
Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
 - Be used on insulated pipe less than 4 inches.
 - Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.
 - Have a high density insert for all pipe sizes.
inserts shall have a density of 8 pcf or greater. High density
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:
 - On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
 - On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
 - On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- m. Where there are high system temperatures and welding to piping is not

desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

- n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3. Structural Attachments

- a. Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roofdecks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

H. Welded Installation

- 1. Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

I. Pipe Cleanouts

- 1. Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron or plastic.

3.2 WATER HEATERS

A. Relief Valves

1. No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold-water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

B. Installation of Gas-Fired Water Heater

1. Installation shall conform to NFPA 54 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

C. Heat Traps

1. Piping to and from each water heater shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

D. Connections to Water Heaters

1. Connections of metallic piping to water heaters shall be made with dielectric unions or flanges.

E. Expansion Tank

1. A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

A. Fixture Connections

1. Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet setting compound of gasket and fixture used.

B. Flushometer Valves

1. Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately 30 inches above the floor and arranged to avoid interference with grab bars. In addition, for water closet intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure.

C. Height of Fixture Rims Above Floor

1. Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Installation of fixtures for use by the physically handicapped shall be in accordance with ICC/ANSI A117.1.

D. Shower Bath Outfits

1. The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

E. Fixture Supports

1. Fixture supports for the off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab.

a. Support for Steel Stud Frame Partitions

- Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy-duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

b. Wall-Mounted Water Closet Gaskets

- Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

F. Backflow Prevention Devices

1. Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with all locations necessary to preclude a cross-connection or interconnect between a potable water supply and any nonpotable substance. In addition, backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

G. Access Panels

1. Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

H. Traps

1. Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311.

I. Shower Pans

Before installing shower pan, subfloor shall be free of projections such as nail heads or rough edges of aggregate. Drain shall be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

1. General
 - a. The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 6 inches for turnup on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any wall or partition finish. Subflooring shall be smooth and clean, with nailheads driven flush with surfaces, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.
2. Nonplasticized Chlorinated Polyethylene Shower Pans
 - Corners of nonplasticized chlorinated polyethylene shower pans shall be folded against the upstand by making a pig-ear fold. Hot-air gun or heat lamp shall be used in making corner folds. Each pig-ear corner fold shall be nailed or stapled 1/2 inch from the upper edge to hold it in place. Nails shall be galvanized large-head roofing nails. On metal framing or studs, approved duct tape shall be used to secure pig-ear fold and membrane.

Where no backing is provided between the studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding 1/2 inch from upper edge. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it will be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Surfaces to be solvent-welded shall be clean. Surfaces to be joined with xylene shall be initially sprayed and vigorously cleaned with a cotton cloth, followed by final coating of xylene and the joining of the surfaces by roller or equivalent means. If ambient or membrane temperatures are below 40 degrees Fahrenheit the membrane and the joint shall be heated prior to application of xylene. Heat may be applied with hot-air gun or heat lamp, taking precautions not to scorch the membrane. Adequate ventilation and wearing of gloves are required when working with xylene. Membrane shall be pressed into position on the drain body and shall be cut and fit to match so that membrane can be properly clamped and an effective gasket-type seal provided. On wood subflooring two layers of 15 pound dry felt shall be installed prior to installation of shower pan to ensure a smooth surface for installation.

3. Nonplasticized Polyvinyl Chloride (PVC) Shower Pans

- Nonplasticized PVC shall be turned up behind walls or wall surfaces a distance of not less than 6 inches in room areas and 3 inches above curb level in curbed spaces with sufficient material to fold over and fasten to outside face of curb. Corners shall be pig-ear type and folded between pan and studs. Only top 1 inch of upstand shall be nailed to hold in place. Nails shall be galvanized large-head roofing type. Approved duct tape shall be used on metal framing or studs to secure pig-ear fold and membrane. Where no backing is provided between studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding at top inch of upstand. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it is to be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Trim for drain shall be exactly the size of drain opening. Bolt holes shall be pierced to accommodate bolts with a tight fit. Adhesive shall be used between pan and subdrain. Clamping ring shall be bolted firmly. A small amount of gravel or porous materials shall be placed at weepholes so that holes remain clear when setting bed is poured. Membrane shall be solvent welded with PVC solvent cement. Surfaces to be solvent welded shall be clean (free of grease and grime). Sheets shall be laid on a flat surface with an overlap of about 2 inches. Top edge shall be folded back and surface primed with a PVC primer. PVC cement shall be applied and surfaces immediately placed together, while still wet. Joint shall be lightly rolled with a paint roller, then as the joint sets shall be rolled firmly but not so hard as to distort the material. In long lengths, about 2 or 3 feet at a time shall be welded. On wood subflooring, two layers of 15 pound felt shall be installed prior to installation of shower pan to ensure a smooth surface installation.

3.4 VIBRATION-ABSORBING FEATURES

- A. Mechanical equipment including compressors and pumps shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together

with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors.

3.5 IDENTIFICATION SYSTEMS

A. Identification Tags

1. Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.
2. Color code marking of piping shall be as specified in ASME A13.1.

3.6 ESCUTCHEONS

- #### A. Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.7 PAINTING

A. Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

1. Factory Painting Systems

- a. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.
- b. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

B. Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing

prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

- a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.
- c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

3.8 TEST, FLUSHING AND DISINFECTION

A. Plumbing system

The following tests shall be performed on the plumbing system in accordance with ICC IPC, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure and reasons for choosing this option in lieu of the smoke test to the Contracting Officer for approval.

1. Drainage and Vent Systems Test as follows:
 - a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - b. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - c. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. Water level must not drop for a period of 24 hours. Inspect joints for leaks.
 - d. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air for 1 hour. Inspect plumbing fixture connections for gas and water leaks.

- e. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
2. Water Supply Systems Tests as follows:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
3. Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

4. Shower Pans
- a. After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 1 inch for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

B. Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

C. System Flushing

1. During Flushing

a. Before operational tests or disinfection, potable water piping system shall be flushed with [hot] potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

2. After Flushing

a. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in PART 2 of this Section. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

D. Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with [EPA SM 9223] [AWWA 10084]. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.10 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, minimum overall efficiency.

ET = Minimum thermal efficiency with 21 degrees C 70 degrees F delta T.

SL = Standby loss is maximum (Btu/h) based on a 38.9 degree C 70 degrees F temperature difference between stored water and ambient requirements.

V = Rated volume in gallons

Q = Nameplate input rate in kW (Btu/h)

A. Storage Water Heaters

1. Gas

- a. Storage capacity of 189 liters 50 gallons or less shall have a minimum energy factor (EF) of 0.67 or higher per FEMP requirements.
- b. Storage capacity of 75.7 liters 20 gallons - or more and input rating of 22980 W 75,000 Btu/h or less: minimum EF shall be 0.62 - 0.0019V per 10 CFR 430.
- c. Rating of less than 22980 W: (75,000 Btu/h) ET shall be 80 percent; maximum SL shall be $(Q/800+110x(V^{1/2}))$, per ANSI Z21.10.3/CSA 4.3

3.11 TABLES

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAINPIPING SYSTEMS								
It #	Pipe and Fitting Materials	SERVIC E A	SERVIC E B	SERVIC E C	SERVIC E D	SERVIC E E	SERVIC E F	SERVICE G
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X	X		
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X			
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X		
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A536 And ASTM A47/A47M	X	X		X	X		
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A536 and ASTM A47/A47M for use with Item 5	X	X		X	X		

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAINPIPING SYSTEMS								
It #	Pipe and Fitting Materials	SERVIC E A	SERVIC E B	SERVIC E C	SERVIC E D	SERVIC E E	SERVIC E F	SERVICE G
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B584, for use with Item 5	X	X		X	X		
8	Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B75/B75M C12200, ASTM B152/B152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X					
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X		
10	Steel pipe, seamless galvanized, ASTM A53/A53M, Type S, Grade B	X			X	X		
11	Seamless red brass pipe, ASTM B43				X	X		X
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X		X
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X		X
14	Seamless copper pipe, ASTM B42						X	X

15	Cast bronze threaded fittings, ASME B16.15				X	X		
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TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAINPIPING SYSTEMS								
It #	Pipe and Fitting Materials	SERVIC E A	SERVIC E B	SERVIC E C	SERVIC E D	SERVIC E E	SERVIC E F	SERVICE G
16	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X	X		X
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X		X
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X		X

SERVICE:

A - Underground Building Soil, Waste and Storm Drain B - Aboveground Soil, Waste, Drain In Buildings
 C - Underground Vent D - Aboveground Vent
 E - Interior Rainwater Conductors Aboveground
 F - Corrosive Waste And Vent Above And Belowground G - Condensate Drain Aboveground

* - Hard Temper

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEM					
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
1	Crosslinked Polyethylene (PEX) Plastic Pipe ASTM F877 with brass fittings ASTM F1807 and stainless steel crimp rings ASTM F2098	X	X		
<p>SERVICE:</p> <p>A - Cold Water Service Aboveground B - Hot and Cold Water Distribution 180 degrees F Maximum Aboveground C - Compressed Air Lubricated D - Cold Water Service Belowground Indicated types are minimum wall thicknesses.</p>					

-- End of Section 22 00 00 --

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 48.00 40 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

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 within the text by the basic designation only. References shall be the latest edition on the date of solicitation.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.71	Guide to the Evaluation of Human Exposure to Vibration in Buildings
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AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS
(ASHRAE)

ASHRAE HVAC APP IP HDBK	HVAC Applications Handbook, I-P Edition
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NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB PROCEDURAL STANDARDS	Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems
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1.2 ADMINISTRATIVE REQUIREMENTS

- A. Within ten working days of Contract Award, submit equipment and performance data for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.
- B. Ensure the data includes information on the following:
1. Type of Isolator
 2. Type of base
 3. Mountings
 4. Floor-Mounted Piping
 5. Vertical Piping
- C. Five working days prior to commencement of installation, submit installation drawings for vibration isolator systems including equipment and performance requirements.
- D. Indicate within outline drawings for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

1.3 SUBMITTALS

- A. SD-02 Shop Drawings
Installation Drawings; G
- B. SD-03 Product Data
Equipment and Performance Data; G

1.4 QUALITY CONTROL

- A. Ensure all vibration-control apparatus is the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

PART 2.0 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Scheduled isolation mounting is in inches and is a minimum static deflection.
- B. Spans referred to in paragraph EQUIPMENT, means longest bay dimension.
- C. Determine exact mounting sizes and number of isolators by the isolator manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.
- D. Design Requirements
Design for vibration isolation using ASHRAE HVAC APP IP HDBK, Chapter 48, as applicable to the following sections.

1. Mountings

Provide the following mountings:

- a. Type A (ASHRAE Type 1): Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading is not to exceed 40 pounds per square inch (psi). Ensure minimum overall thickness is 1 inch. Maximum deflections up to 0.25-inch are allowed.
- b. Type B (ASHRAE Type 3): Double elastomer-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 0.50-inch are allowed.
- c. Type C (ASHRAE Type 3): Free-standing laterally stable open-spring type for deflections over 0.50-inch, with built-in bearing and leveling provisions, 0.25-inch thick Type A base elastomer pads, and accessories. Ensure outside diameter of each spring is equal to or greater than 0.9 times the operating height of the spring under rated load.
- d. Type F (ASHRAE Type 3): Combination spring and rubber-in-shear steel framed for hanger-rod mounting, with minimum total static deflection of 1-inch.

2. Bases

Provide the following bases:

- a. Type U (ASHRAE Type A): Unit isolators without rails, structural-steel bases, or inertia blocks.
- b. Type R (ASHRAE Type B): Rails, connected mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight.
- c. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.
- d. Type S (ASHRAE Type B): Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.

Ensure height of steel members is sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Ensure height of steel member does not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height is 5-inches.

- e. Type CIB (ASHRAE Type C): Provide concrete inertia blocks common to the entire assembly, with welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 8-inches on center each way near the bottom of the block, outrigger-isolator mounting provisions, anchor bolts. Fill with 3,000 psi cured-strength concrete.

3. Configure rectangular inertia bases to accommodate equipment supported.

- 4. Ensure minimum thickness of inertia base, in addition to providing suitable mass, is sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components, and is sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Verify

minimum thickness, the preceding requirements notwithstanding, is 8 percent of the longest base dimension.

5. Ensure pumps with flexible couplings do not have inertia base less than 8-inches thick, and the minimum mass of concrete inertia block is equal in weight to supported equipment.

2.2 EQUIPMENT

- A. Vibration isolation design per ASHRAE HVAC APP IP HDBK, Chapter 48.
- B. Medium- and High-Pressure AHU Locations
 1. Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Classes B and C packaged central-station units without full internal vibration isolation.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON/ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON/ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON/ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-U-2.5	C-U-3.5
300 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-2.5
500 rpm and over	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.75
Over 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-CIB-3.5	C-CIB-3.5
300 to 500 rpm	B-U-0.35	C-U-2.5	C-CIB-2.5	C-CIB-3.5
500 rpm and over	B-U-0.35	C-U-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.3 MATERIALS

- A. Ensure rubber is natural rubber and elastomer is chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.
- B. Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.
- C. Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations. Ensure rails, structural steel bases, and concrete inertia blocks are raised not less than 1-inch above the floor and are level when equipment supported is under operating load.

-- End of Section 23 05 48.00 40 --

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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 within the text by the basic designation only. References shall be the latest edition on the date of solicitation.

1. AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 203		Field Performance Measurements of Fan Systems
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2. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-
CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1		Ventilation for Acceptable Indoor Air Quality
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3. ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1		National Standards for Total System Balance
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AABC MN-4		Test and Balance Procedures NATIONAL
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4. AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE		NASA Reliability Centered Building and Equipment Acceptance Guide
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5. NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV		Procedural Standards for Measurements and Assessment of Sound and Vibration
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NEBB PROCEDURAL STANDARDS		Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems
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6. SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1858	HVAC Sound And Vibration Manual - First Edition
SMACNA 1972 CD	HVAC Air Duct Leakage Test Manual 2nd Edition

7. U.S NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone
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1.2 DEFINITIONS

1. AABC: Associated Air Balance Council
2. COTR: Contracting Officer's Technical Representative
3. DALT: Duct air leakage test
4. DALT'd: Duct air leakage tested
5. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling
6. NEBB: National Environmental Balancing Bureau
7. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class." "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."
8. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.
9. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.
10. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

11. TAB: Testing, adjusting, and balancing (of HVAC systems)
12. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed
13. TAB Agency: TAB Firm
14. TAB team field leader: TAB team field leader
15. TAB team supervisor: TAB team engineer
16. TAB team technicians: TAB team assistants
17. TAB team field leader: TAB team field leader
18. TAB team supervisor: TAB team engineer
19. TAB team technicians: TAB team assistants
20. TABB: Testing Adjusting and Balancing Bureau

A. Similar Terms

1. In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.
2. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

1. The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air

distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

2. Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.
 3. Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.
- A. Air Distribution Systems
1. Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.
- B. Water Distribution Systems
- a. TAB system in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.
 - b. Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.
 - c. After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.
- C. TAB SCHEMATIC DRAWINGS
- Show the following information on TAB Schematic Drawings:
- a. A unique number or mark for each piece of equipment or terminal.
 - b. Air quantities at air terminals.
 - c. Air quantities and temperatures in air handling unit schedules.
 - d. Water quantities and temperatures in thermal energy transfer equipment schedules.
 - e. Water quantities and heads in pump schedules.
 - f. Water flow measurement fittings and balancing fittings.
 - g. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test

pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications:

<http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-gra>

1. The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation. The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.
2. Submit three copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

D. Related Requirements

1. Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.
2. Specific requirements relating to Reliability Centered Maintenance (RCM) principals and Predictive Testing and Inspection (PTI), by the construction contractor to detect latent manufacturing and installation defects must be followed as part of the Contractor's Quality Control program. Refer to the paragraph SUSTAINABILITY for detailed requirements.

1.4 SUBMITTALS

- A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.
- B. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
 1. SD – 01 Preconstruction Submittals
 - a. Independent TAB Agency and Personnel Qualifications; G
 - b. TAB Design Review Report; G
 - c. TAB Firm; G
 2. SD – 03 Product Data
 - a. TAB Procedures;
 - Proposed procedures for TAB, submitted with the Tab Schematic
 - b. Drawings and Report Forms; G
 - c. Calibration;
 3. SD – 06 Test Reports
 - a. Completed Pre-Final DALT Report; G
 - b. Certified Final DALT Report; G
 - c. Prerequisite Final DALT Report; G
 - d. Certified Final TAB Report for Proportional Balancing; G
 4. SD – 07 Certificates
 - a. Instrument Calibration Certificates;
 - b. DALT and TAB Procedures Summary;

1.5 QUALITY ASSURANCE

- A. Independent TAB Agency and Personnel Qualifications

1. To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:
 - a. Independent AABC or NEBB or TABB TAB agency:
 - TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.
 - TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.
 - TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.
 - TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.
 - Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.
 - b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.
 - c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.
2. TAB Standard
 - a. Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.
 - b. All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures

must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

3. Qualifications

a. TAB Firm

- The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems .
- Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TBB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.
- These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

b. TAB Specialist

- The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

c. TAB Specialist Responsibilities

- TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.

4. TAB Related HVAC Submittals

- #### a. The TAB Specialist must prepare a list of the submittals from the Contract

Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

B. Responsibilities

1. The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

2. Contractor

- a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.
- b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor where applicable.
- c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:
 - Contract drawings and specifications
 - Approved submittal data for equipment
 - Construction work schedule
 - Up-to-date revisions and change orders for the previously listed items
- d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.
- e. Coordination of supporting personnel:
 - Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.
 - Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.
 - Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.
- f. Deficiencies: Ensure that the TAB Agency supervisor submits all

Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

- g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.
 - h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.
 - HVAC system installations are fully complete.
 - HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.
 - DALT field checks for all systems are completed.
 - HVAC system filters are clean.
 - i. Insulation work: For required DALT work, ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.
3. TAB Agency
 - a. Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.
4. TAB Team Supervisor
 - a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.
 - b. Pre-DALT/TAB meeting: Attend meeting with Contractor.
 - c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.
 - d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field

engineering report, the during the DALT or TAB field work.

- e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.
- f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.
- g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.
- h. Technical assistance for DALT work.
 - Technical assistance: Provide immediate technical assistance to TAB field team.
 - DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report.
- i. Final DALT report: Certify the DALT report. This certification includes the following work:
 - Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.
 - TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.
- j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.
- k. Certified TAB report: Certify the TAB report. This certification includes the following work:
 - Review: Review the TAB field data report. From this field report, prepare the certified TAB report.
 - Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.
- l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.
- m. TAB Field Check: The TAB team supervisor must attend and supervise TAB field check.

5. TAB Team Field Leader

- a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.
- b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.
- c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

C. Sequencing and Scheduling

TAB Pre-Field Engineering Report

Submit report containing the following information:

- a. Step-by-step TAB procedure:
 - Strategy: Describe the method of approach to the TAB field work from start to finish.
 - Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.
 - Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.
- b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:
 - Design data obtained from system drawings, specifications, and approved submittals.
 - Notations detailing additional data to be obtained from the contract site by the TAB field team.
 - Designate the actual data to be measured in the TAB field work.
 - Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.
- c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be

acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

- d. At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

D. Subcontractor Special Requirements

1. Perform all work in this section so that all contract requirements of this section must be accomplished directly by a first tier subcontractor. No work may be performed by a second tier subcontractor.

E. Instrument Calibration Certificates

1. It is the responsibility of the TAB firm to provide instrumentation that meets the minimum requirements of the standard under which the TAB Firm's qualifications are approved for use on a project. Instrumentation must be in proper operating condition and must be applied in accordance with the instrumentation's manufacturer recommendations.
2. All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing. All instrumentation must be calibrated within no later than one year of the date of TAB work or government acceptance testing field work.

F. TAB Standard

1. Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.
2. All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

G. Sustainability

1. Contractor must submit the following as part of the Quality Control Plan for acceptance testing:
 - a. List all test equipment to be used, including its manufacturer, model number, calibration date, and serial number.
 - b. Certificates of test personnel qualifications and certifications. Provide certification of compliance with 40 CFR 82.

- c. Proof of equivalency if the contractor desires to substitute a test requirement.
 2. Perform the following PTI as an integral part of the TAB process per the most recent edition of the NASA RCBEA GUIDE:
 - a. Compressors:
 - Note any vibration anomalies
 - Balance Test and Measurement
 - Alignment if applicable (laser preferred)
 - Lubricating Oil Test
 - Thermodynamic Performance Test
 - Hydraulic Oil Test (optional)
 - b. Fans:
 - Note any vibration anomalies
 - Balance Test and Measurement
 - Alignment (laser preferred)
 - Lubricating Oil Test
 - Thermodynamic Performance Test
 - c. Heat Exchangers (General):
 - Hydrostatic Test
 - Airborne Ultrasonic Test
 - Thermodynamic Performance Test
 - Infrared Thermography (optional)
 - d. Heat Exchangers (Condenser Air Cooled):
 - Hydrostatic Test
 - Thermodynamic Performance Test
 - Airborne Ultrasonic Test (optional)
 - Pulse Ultrasonic Test (optional)
 - Infrared Thermography (optional)
 - e. HVAC Ducts:
 - Operational Test
 - Ductwork Leak Testing (DALT); Pre-Final DALT report, Final DALT report
- H. Qualifications
 1. TAB Firm
 - a. The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems.
 - b. Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

- c. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.
 2. TAB Specialist
 - a. The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.
 3. TAB Specialist Responsibilities
 - a. TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.
 4. TAB Related HVAC Submittals
 - a. The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.
- I. Responsibilities
1. The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.
 2. Contractor
 - a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.
 - b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.
 - c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:
 - Contract drawings and specifications

- Approved submittal data for equipment
 - Construction work schedule
 - Up-to-date revisions and change orders for the previously listed items
- d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.
- e. Coordination of supporting personnel:
- Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.
 - Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.
 - Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.
- f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.
- g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.
- h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.
- HVAC system installations are fully complete.
 - HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.
 - DALT field checks for all systems are completed.
 - HVAC system filters are clean.
- i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

- j. Insulation work: For required DALT work, ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

3. TAB Agency

- a. Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

4. TAB Team Supervisor

- a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.
- b. Pre-DALT/TAB meeting: Attend meeting with Contractor.
- c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.
- d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.
- e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.
- f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.
- g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.
- h. Technical assistance for DALT work.
 - Technical assistance: Provide immediate technical assistance to TAB field team.
 - DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to

issue certification of the final report.

- i. Final DALT report: Certify the DALT report. This certification includes the following work:
 - Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.
 - TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.
- j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.
- k. Certified TAB report: Certify the TAB report. This certification includes the following work:
 - Review: Review the TAB field data report. From this field report, prepare the certified TAB report.
 - Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.
- l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.
- m. TAB Field Check: The TAB team supervisor must attend and supervise TAB field check.

5. TAB Team Field Leader

- a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.
- b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.
- c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

J. Test Reports

1. Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

- a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section.

Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

- b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition, provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.
- c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.
- d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

2. Certified TAB Reports

Submit: TAB Report in the following manner:

- a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.
- b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:
 - All Rooms: Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.
 - Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.
 - Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the TAB Report.
- c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.
- d. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

- Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.
- Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.
- Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry (where present).
- Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers (where present).

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

- Report static pressure drop across outside air and relief/exhaust air louvers.
 - Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.
- e. Duct Traverses: Report duct traverses for main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."
- f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.
- g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.
- h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.
- i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

1.6 SEQUENCING AND SCHEDULING

A. DALT and TAB Submittal and Work Schedule

1. Comply with additional requirements specified in Appendix C: DALT AND

TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

2. Submit this schedule, and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.
3. TAB Design Review Report
 - a. Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.
4. Pre-Field DALT Preliminary Notification
 - a. Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.
5. TAB Pre-Field Engineering Report

Submit report containing the following information:

- a. Step-by-step TAB procedure:
 - Strategy: Describe the method of approach to the TAB field work from start to finish.
 - Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.
 - Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.
- b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:
 - Design data obtained from system drawings, specifications, and approved submittals.
 - Notations detailing additional data to be obtained from the contract site by the TAB field team.
 - Designate the actual data to be measured in the TAB field work.
 - Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each

item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

- c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.
- d. At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.7 WARRANTY

- A. Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 1 year from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm.

2 PART 2 - PRODUCTS

Not Used

3 PART 3 - EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

- A. Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

3.2 PRE-DALT/TAB MEETING

- A. Meet with the Contracting Officer's technical representative (COTR) to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.3 DALT PROCEDURES

- A. Instruments, Consumables and Personnel
 - 1. Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

- B. Advance Notice of Pre-Final DALT Field Work
Advance Notice of Pre-Final DALT Field Work
 - 1. On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.
- C. Ductwork To Be DALT'd
 - 1. From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.
 - 2. It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.
- D. DALT Testing
 - 1. Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.
 - 2. In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.
- E. Completed Pre-Final DALT Report
 - 1. After completion of the DALT work, prepare a Pre-final DALT Report meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.
 - 2. TAB supervisor shall review, approve and sign the Pre-Final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-Final DALT Report data can commence. After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.
- F. Quality Assurance - COTR DALT Field Acceptance Testing
 - 1. In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.
 - 2. Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the

presence of the COTR.

G. Additional COTR Field Acceptance Testing

1. If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

H. Certified Final DALT Report

1. On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval. On successful completion of all field checks of the Pre-Final DALT Report data for all systems, the TAB Supervisor shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB to the Contracting Officer for approval.

I. Prerequisite for TAB Field Work

1. Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

A. TAB Field Work

1. Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.
2. That is, comply with the the requirements of AABC MN-1 and AABC MN-4, NEBB PROCEDURAL STANDARDS, NEBB MASV, or SMACNA 1780 (TABB) and SMACNA 1858 (TABB), except as supplemented and modified by this section.
3. Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.
4. Test, adjust, and balance the HVAC systems until measured flow rates (air flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.

B. Preliminary Procedures

1. Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

C. TAB Air Distribution Systems

Units With Coils

1. Report heating and cooling performance capacity tests for DX coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:
 - a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."
 - Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."
 - Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).
 - b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:
 - Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.
 2. Heating and Ventilating Units
 - a. Heating and ventilating unit systems including fans, coils, ducts, plenums, roof vents, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.
 3. Fan Coils
 - a. Fan coil unit systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.
 4. Exhaust Fans
 - a. Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.
 5. Unit Heaters
- D. TAB Work on Performance Tests Without Seasonal Limitations
1. Performance Tests
 - a. In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.
 2. Ambient Temperatures
 - a. On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

E. Workmanship

1. Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

F. Deficiencies

1. Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.
2. Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

G. TAB Reports

1. Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB
2. Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.
3. Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

H. Quality Assurance - COTR TAB Field Acceptance Testing

1. TAB Field Acceptance Testing
 - a. During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion, sound level readings) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.
 - b. Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:
 - Group 1: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units or fan and coil units.
 - Group 2: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.
 - Group 3: 25 percent of the supply fans and exhaust fans.

- c. Further, if any data on the TAB Report for Groups 1 through 3 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

2. Additional COTR TAB Field Acceptance Testing

- a. If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.
- b. Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.
- c. If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3. Prerequisite for Approval

- a. Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

3.5 MARKING OF SETTINGS

- A. Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.6 MARKING OF TEST PORTS

3.7

- A. The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

3.8 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS

Appendix B REPORTS - DALT and TAB

Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1.1 Contractor

- A. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.
- B. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.
- C. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.
- D. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.
- E. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph CONSTRUCTION DEFICIENCIES. Correct each deficiency as soon as practical with the Contracting Officer, and submit revised schedules and other required documentation.
- F. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.
- G. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.
- H. Give Notice of Testing: Submit advance notice of proportional balancing TAB field work accompanied by completed prerequisite HVAC Work List
- I. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.
- J. Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

1.2 TAB Team Supervisor

- A. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.
- B. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.
- C. Submittals: Provide the submittals specified herein.
- D. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.
- E. Design Review Report: Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.
- F. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.
 - 1. Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.
 - 2. Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.
- G. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.
- H. Technical Assistance: Provide technical assistance to the DALT and TAB field work.
- I. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph CONSTRUCTION DEFICIENCIES. Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.
- J. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

1.3 TAB Team Field Leader

- A. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.
- B. Full Time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB Team; ensure day-to-day TAB team work accomplishments are in compliance with this section.
- C. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B REPORTS

DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1.1 DALT and TAB Work Execution Schedule

- A. Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

1.2 DALT and TAB Procedures Summary

- A. Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:
 - 1. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.
 - 2. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.
 - 3. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.
 - 4. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.
 - 5. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.
 - 6. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.
 - 7. A thorough checklist of the work items and inspections that need to be accomplished before the TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-TAB Work Checklist before the TAB field work can be accomplished.
 - 8. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

1.3 Design Review Report

- A. Submit report containing the following information:
1. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.
 2. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

1.4 Completed Pre-Final DALT Work Checklist

Report the data for the Pre-Final DALT Report meeting the following requirements:

- A. Submit a copy of the approved DALT and TAB Procedures Summary:
Provide notations describing how actual field procedures differed from the procedures listed.
- B. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Node numbers shall be included in the completed report forms to identify each duct section.
- C. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.
- D. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments are to be calibrated within one year of the date of use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and Technology.
- E. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5 Final DALT Report

- A. On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer for approval.

1.6 TAB Reports: Submit TAB Report for Proportional Balancing in the following manner:

- A. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

- B. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.
- C. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

All Rooms

1. Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.
 2. Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.
 3. Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the TAB Report.
- D. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.
- E. Air Static Pressure Profiles: Report static pressure profiles for air duct systems including: all fan & coil units. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

1. Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.
2. Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork (where present).
3. Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry (where present).
4. Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers (where present).

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

5. Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.
- F. Duct Transverses: Report duct traverses for main supply, return, exhaust, relief and outside air ducts. The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane".
- G. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings shall provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.
- H. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.
- I. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.
- J. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below.

- 1.1 Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.
- 1.2 Submit the DALT and TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval.
- 1.3 Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB work.
- 1.4 Submit the DALT and TAB Work Procedures Summary: within 14 days after receipt of the initial approved DALT and TAB Work Execution Schedule.
- 1.5 Meet with the COTR at the Pre-DALT/TAB Meeting: Within 28 calendar days after receipt of the approved initial DALT/TAB Execution Schedule.
- 1.6 Submit Design Review Report: Within 56 calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.
- 2 Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Contracting Officer an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist for the subject duct system.
 - 2.1 Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's technical representative (COTR) will select the project ductwork sections to be DALT'd.
 - 2.2 DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.
 - 2.3 Submit Pre-Final DALT Report: Within two working days after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.
 - 2.4 Quality Assurance - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Contracting Officer.
 - 2.5 Submit Final DALT Report: Within 14 calendar days after completion of successful DALT Work Field Check, submit TAB report.
 - 2.6 Advance Notice of TAB Field Work: At a minimum of 14 calendar days prior to TAB Field Work, submit advance notice of TAB field work accompanied by completed Pre-TAB Work Checklist.
 - 2.7 TAB Field Work: At a minimum of 84 calendar days prior to CCD,
 - 2.8 accomplish TAB field work.
 - 2.9 Submit TAB Report: Within 14 calendar days after completion of TAB field work, submit initial TAB report.
 - 2.10 Quality Assurance - COTR TAB Field Check: 30 calendar days after initial TAB report is approved by the Contracting Officer, conduct field check.
 - 2.11 Complete TAB Work: Prior to CCD, complete all TAB work and submit final.

2.12 Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.

3 Receive the approved TAB report: Within calendar 21 days, receive the report from Contracting Officer.

-- End of Section 23 05 93--

SECTION 23 07 00 - THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. General

1. Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated.

B. Surface Burning Characteristics

1. Unless otherwise specified, insulation shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84. Flame spread, and smoke developed indexes, shall be determined by ASTM E 84 or UL 723.

1.2 SUBMITTALS

1. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

a. SD-03 Product Data

- Pipe Insulation Systems; G
- Duct Insulation Systems; G
- Equipment Insulation Systems;

b. SD-08 Manufacturer's Instructions

- Pipe Insulation Systems; Duct Insulation Systems;
- Equipment Insulation Systems;

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material. Insulation packages and containers shall be asbestos free

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

- A. Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems which are located within, on, under, and adjacent to buildings; and for plumbing systems. Insulation shall be CFC and HCFC free.

2.2 MATERIALS

- A. Provide insulation that meets or exceed the requirements of ASHRAE 90.1 - IP. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following: Flexible Elastomeric: Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive. Comply with ASTM C 534/C 534M, Type I, Grade 1, for tubular materials and Type II, Grade 1, for sheet materials. Provide product recognized under UL 94 and listed in FM APP GUIDE.
- B. Adhesives
1. Acoustical Lining Insulation Adhesive
 - a. Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.
 2. Mineral Fiber Insulation Cement
 - a. Cement shall be in accordance with ASTM C 195.
 3. Lagging Adhesive
 - a. Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84. Adhesive shall be MIL-A-3316, Class 1, pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation.
 4. Contact Adhesive
 - a. Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation shall be used to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product recognized under UL 94 and listed in FM APP GUIDE.
- C. Caulking
1. ASTM C 920, Type S, Grade NS, Class 25, Use A.

- D. Corner Angles
 - 1. General
 - a. Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.
 - 2. Fittings
 - a. Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor).
- E. Finishing Cement
 - 1. ASTM C 449: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C 795.
- F. Fibrous Glass Cloth and Glass Tape
 - 1. Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.
- G. Staples
 - 1. Outward clinching type ASTM A167, Type 304 or 316 stainless steel.
- H. Jackets
 - 1. Aluminum Jackets
 - a. Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.
 - 2. Polyvinyl Chloride (PVC) Jackets
 - a. Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch. PVC jackets shall only be used indoors.
- I. Vapor Barrier
 - 1. ASTM C 921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

Based on the application, insulation materials that require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. Insulation materials that do not require factory applied jacketing are flexible elastomerics. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

2. White Vapor Retarder All Service Jacket (ASJ)
 - a. Standard reinforced fire retardant jacket for use on hot/cold pipes, ducts, or equipment. Vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.
3. Vapor Barrier Mastic Coatings
 - a. The vapor barrier shall be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Less than 0.02 permeability when tested in accordance with ASTM E 96/E 96M. Meeting UL 723 or ASTM E 84 flame and smoke requirements; UV resistant.
4. Vapor Barrier
 - a. The vapor barrier shall be greater than 3 ply self adhesive laminate -white vapor barrier jacket-superior performance (less than 0.0000 permeability when tested in accordance with ASTM E 96/E 96M). Vapor barrier shall meet UL 723 or ASTM E 84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 185 psi in accordance with TAPPI T403 OM or ISO 2758. Tensile strength 68 lb/inch width (PSTC-1000). Tape shall be as specified for laminated film vapor barrier above.

J. Wire

1. Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

K. Insulation Bands

1. Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

L. Sealants

1. Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum moisture vapor transmission of 0.02 perms, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

2.3 PIPE INSULATION SYSTEMS

- A. Insulation materials shall conform to Table 1. Insulation thickness shall be as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - IP. Insulation thickness shall be 1/2 inch minimum. Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

B. Aboveground Pipeline

1. Insulation for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.
 - a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.
 - b. Flexible Elastomeric Cellular Insulation: ASTM C 534/C 534M, Grade 1, Type I or II to 220 degrees F service.

C. Above Ground Dual Temperature Pipeline

1. Selection of insulation for use over a dual temperature pipeline system (Outdoors, Indoor - Exposed or Concealed) shall be in accordance with the most limiting/restrictive case. Find an allowable material from paragraph INSULATION MATERIALS table and determine the required thickness from the most restrictive case. Use the thickness listed in paragraphs INSULATION THICKNESS for cold & hot pipe applications.

2.4 DUCT INSULATION SYSTEMS

A. Duct Insulation

1. Provide factory-applied insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier.
2. Rigid Insulation
 - a. Rigid mineral fiber in accordance with ASTM C 612, Class 2 (maximum surface temperature 400 degrees F), 3 pcf average, Type IA, IB, II, III, and IV. Alternately, minimum thickness may be calculated in accordance with ASHRAE 90.1 - IP.
3. Blanket Insulation
 - a. Blanket flexible mineral fiber insulation conforming to ASTM C 553, Type 1, Class B-3, 3/4 pcf nominal, Type II up to 250 degrees F. Also ASTM C 1290 Type III may be used. Alternately, minimum thickness may be calculated in accordance with ASHRAE 90.1 - IP.

B. Duct Insulation Jackets

1. All-Purpose Jacket
 - a. Provide insulation with insulation manufacturer's standard foil skim kraft (FSK) reinforced fire-retardant jacket with integral vapor barrier.
2. Metal Jackets
 - a. Galvanized Jackets: Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A924/A924M and ASTM A653/A653M, Designation G90. Treat duct surfaces to be painted by phosphatizing.

2.5 EQUIPMENT INSULATION SYSTEMS

- A. Insulate equipment and accessories as specified. In outside locations, provide insulation 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface.

PART 3 - EXECUTION

3.1 APPLICATION - GENERAL

- A. Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.
- B. Installation
 1. Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed

from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with the manufacturer's written instructions except where modified herein or on the drawings.

C. Installation of Flexible Elastomeric Cellular Insulation

1. Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

D. Welding

1. No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

E. Pipes/Ducts/Equipment which Require Insulation

1. Insulation is required on all pipes, ducts, or equipment, except for omitted items, as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

A. Pipe Insulation

1. General

Pipe insulation shall be installed on aboveground pipeline systems as specified below to form a continuous thermal barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

- a. Pipe used solely for fire protection.
- b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the cold and hot water supply and drain, including the trap, insulated where exposed.
- c. Sanitary drain lines.
- d. Air chambers.
- e. Adjacent insulation.
- f. ASME stamps.
- g. Access plates of fan housings.
- h. Cleanouts or handholes.

- i. On piping with fluids above 60 degrees F, do not insulate control valves, unions, flanges and other valves and items that are removable. Pencil insulation as it approaches these items and vapor barrier coat the penciled ends with two coats of vapor barrier coating.

2. Pipes Passing Through Walls, Roofs, and Floors

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket shall be provided over the insulation wherever penetrations require sealing.
- c. Where pipes penetrate interior walls, the aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.
- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.
- e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.
- f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.
- g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor barrier coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.
- h. For hot water pipes supplying lavatories or other similar heated service that requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the pipe and wall penetration shall be caulked with approved fire stop material. The pipe and wall penetration shall be covered with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inches.
- i. For domestic cold water pipes supplying lavatories or other similar cooling service that requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the outer surface of the pipe insulation and the wall penetration shall be caulked with an approved fire stop material having vapor retarder properties. The pipe and wall penetration shall be covered with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inches.

3. Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.
- b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on

hangers in accordance with MSS SP-69, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

- c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass, prefabricated insulation pipe hangers, perlite above 80 degrees F), or the necessary strength polyisocyanurate shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.
 - d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.
 - e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.
4. Flexible Elastomeric Cellular Pipe Insulation
 - a. Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.
 5. Pipes in high abuse areas.
 - a. In high abuse areas such as janitor closets and traffic areas in equipment rooms, and mechanical rooms, aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive, vapor barrier/weatherproofing jacket, or aluminum jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.
 6. Insulate Pipe with Material listed in Table 1 to the thickness listed in Table 2.

TABLE 1					
Insulation Material For Piping (°F)					
Service	Material	Spec	Type	Class	Vapor Barr'r Required
Above Grade Domestic Water	Mineral Fiber	ASTM	C 547	1	Yes
Water Piping & Makeup Water Piping	Flex Elast Cell'r	ASTM	C 534/C 534M	1	No
Refrigerant Suction Piping (35 °F nominal)	Flex Elast Cell'r	ASTM	C 534/ C534M	1	No
Exposed Lav'ry Drains, Expo'd Piping & Drains to Areas for Handicap Personnel	Flex Elast Cell'r	ASTM	C 534/C 534M	1	No
A/C condensate	Flex Elast Cell'r	ASTM	C 534/C 534M	1	No
Piping not listed above with fluids below 60°F	Mineral Fiber	ASTM	C 547	1	No
	Flex Elast Cell'r	ASTM	C 534/C 534M	1	No
Piping Not listed above Subject to ambient condidtions below 32°F	Mineral Fiber	ASTM	C 547	1	No
	Flex Elast Cell'r	ASTM	C 534/C 534M	1	No

Note: Subject to approval, prefabricated piping Domestic Water insulation assemblies shall be allowed.

TABLE 2							
Piping Insulation Thickness (inch and °F)							
Service	Material	Tube And Pipe Size (Inches)					
		< 1	1 - < 1.5	1.5 - < 4	4 - < 8	> = 8	
Cold Domestic	Mineral Fiber	0.5	0.5	0.5	0.75	1	
Water Piping, Makeup Water Piping (indoors)	Flex Elas. Cell'r	0.5	0.5	0.5	0.75	1	
Cold Domestic	Mineral Fiber	0.75	0.75	0.75	1	1.5	
Water Piping, Makeup Water Piping (indoors)	Flex Elas Cell'r	0.75	0.75	0.75	1	1	

TABLE 2							
Piping Insulation Thickness (inch and °F)							
Service	Material	Tube And Pipe Size (Inches)					
		< 1	1 - < 1.5	1.5 - < 4	4 - < 8	> = 8	
Makeup Water Piping (outdoors)	Mineral Fiber	1	1	1	1.5	1.5	
Hot Domestic Water Supply and Recirculating Piping (Max 200°F)	Flex Elas Cell'r	0.75	0.75	1	1	1	
Refrigerant Suction Piping (35°F nominal)	Flex Elas Cell'r	0.75	0.75	1	1.5	2	
Exposed Lavatory Drains, Expo'd Piping & Drains to Areas for handicap Personnel	Flex Elas Cell'r	0.5	0.5	0.5	0.5	0.5	
A/C condensate (all locations)	Flex Elas Cell'r	0.75	0.75	0.75	N/A	N/A	
Piping Not listed above with fluids below 60°F	Mineral Fiber	0.75	0.75	0.75	1	1.5	
	Flex Elas Cell'r	0.75	0.5	0.5	0.75	1	
Piping Not listed above Subject to ambient conditions below 32°F	Mineral Fiber	0.75	0.75	0.75	1	1.5	
	Flex Elas Cell'r	0.75	0.75	0.75	0.75	1	

B. Aboveground Pipelines

1. Installing Insulation for Straight Runs of Pipe

- a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with joint sealant.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on inch centers if not factory self-sealing.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. Insulation systems requiring a vapor barrier: All seams and staples shall be coated with vapor barrier coating. This includes factory self-seal lap systems.
- f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor barrier coating. The patch shall extend not less than 1-1/2 inches past the break.
- g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor barrier coating.
- h. Installation of flexible elastomeric cellular pipe insulation shall be by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Grade 1, Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

2. Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant.
- b. Precut or preformed insulation shall be placed around all fittings and accessories. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. The joints shall be sealed with a vapor barrier coating on insulation systems that require a vapor barrier. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter.
- c. On insulation systems requiring a vapor barrier, upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor barrier jackets or PVC fitting covers, the seams and joints shall be covered with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches.
- d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

- e. Insulation shall be marked showing the location of unions, strainers, and check valves that are concealed by the insulation.

3. Optional PVC Fitting Covers

- a. At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall have the same density, thickness, and thermal conductivity as the adjoining pipe insulation. The covers shall be secured by PVC vapor barrier tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor barrier coating to ensure that the assembly has a continuous vapor seal on systems requiring vapor barriers.

C. Piping Exposed to Weather

- 1. Piping exposed to weather shall be insulated as specified for the applicable service as listed in Table 2. After this procedure, a aluminum jacket shall be applied. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION in PART 3 .
- 2. Aluminum Jacket
 - a. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.
- 3. Insulation for Fittings
 - a. Factory preformed aluminum jackets shall be used for flanges, unions, valves, fittings, and accessories.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

- A. Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces where the difference between supply air temperature and room air temperature is less than 15 degrees F unless otherwise shown. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).
- B. Insulate Ductwork with the materials listed in Table 3

TABLE 3	
Duct Insulation Schedule	
Service	Material
Ductwork located in concealed locations (ie: above ceilings, in chases, inside walls, etc.):	
Supply Air	Blanket Flexible or Rigid Mineral Outside Air & Mixed Air Plenums
Ductwork located in exposed, finished locations:	
Supply Air, Air & Mixed Air Plenums	Accustical Duct Liner Outside
Ductwork located in exposed, unfinished locations (ie.: in mechanical rooms, utility closets, etc.):	
Supply Air, Outside Air & Mixed Air Plenums	Rigid Mineral

C. Duct Insulation Thickness

1. Duct insulation thickness shall be as required to meet the minimum R-Value stated in ASHRAE 90.1 and as indicated in Table 4.

TABLE 4		
Minimum Duct Insulation R_Value		
Service	Material	Min R-Value
In locations where the difference between airstream temperature and ambient air temperature is less than 15 degrees F:		
Supply Air	Blanket Flexible	R - 2
Outside Air	Rigid Mineral	R - 2
Mixed Air Plenums	Double Wall Liner	R - 2
In locations where the difference between airstream temperature and ambient air temperature is greater than 15 degrees F:		
Supply Air	Blanket Flexible	R - 6
Outside Air	Rigid Mineral	R - 6
Mixed Air Plenums	Double Wall Liner	R - 6

D. Insulation and Vapor Barrier for Ducts

1. Insulation and vapor barrier shall be provided for the following ducts and associated equipment:
 - a. Supply ducts.
 - b. Flexible run-outs (field-insulated).
 - c. Plenums.
 - d. Duct-mounted coil casings.
 - e. Coil headers and return bends.
 - f. Coil casings.
 - g. Fresh air intake ducts.
 - h. Filter boxes.
 - i. Mixing boxes (field-insulated).
 - j. Supply fans (field-insulated).
 - k. Ducts exposed to weather.
 - l. Combustion air intake ducts.
2. Installation of Blanket Flexible insulation
 - a. Insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
 - b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
 - c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
 - d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.
 - e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.
 - f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor barrier coating.
 - g. Breaks in the jacket material shall be covered with patches of the same material as the insulation jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor barrier coating.
 - h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled with insulation and the penetration sealed with a brush

coat of vapor barrier coating.

- i. Insulation terminations and pin punctures shall be sealed and flashed with tape with a brush coat of vapor barrier coating. The coating shall overlap the adjoining insulation and un-insulated surface inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3. Installation of Rigid Mineral Insulation

- a. Rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct or insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers as recommended by the manufacturer. Mechanical fasteners shall be spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches. Mechanical fasteners shall be as corrosion resistant as G60 coated galvanized steel, and shall indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.
- b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners or adhesive. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.
- c. Where mechanical fasteners are used, insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.
- d. Joints in the insulation jacket shall be sealed with a 4 inch wide strip of tape. Tape seams shall be sealed with a brush coat of vapor barrier coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor barrier coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor barrier coating.
- g. Insulation terminations shall be sealed with a brush coat of vapor barrier coating. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

4. Installation of Acoustical Duct Liner

- a. Acoustical duct liner shall be installed in accordance with the manufacturers instructions.
- b. Insulation shall be attached by applying adhesive around the entire perimeter of the duct.

5. Installation of Mineral Fiber

- a. Mineral fiber insulation shall be installed in accordance with the manufacturers instructions.

E. Duct Test Holes

1. After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket

shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

F. Duct Exposed to Weather

1. Installation

- a. Ducts exposed to weather shall be insulated and finished as specified for the applicable service for ductwork in exterior locations. After the above is accomplished, the insulation shall then be jacketed with a galvanized steel metal jacket. The jacket shall be installed with the joints lapped not less than 3 inches and secured with bands or screws located at circumferential laps and at not more than 12 inch intervals throughout. Horizontal joints shall lap down to shed water and located at or 8 o'clock position. Joints shall be sealed with caulking to prevent moisture penetration. Where jacketing abuts an un-insulated surface, joints shall be sealed with caulking.

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

A. General

1. Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:
 - a. Hand-holes.
 - b. Boiler manholes.
 - c. Cleanouts.
 - d. ASME stamps.
 - e. Manufacturer's nameplates.
 - f. Duct Test/Balance Test Holes.

B. Insulation for Equipment

1. Insulate equipment operating below 60 degrees F or above 95 degrees F as well as equipment subject to freezing. Insulation shall be furnished on equipment including but not limited to the following:
 - a. Pumps.
 - b. Refrigeration equipment parts that are not factory insulated.
 - c. Drip pans under chilled equipment.
 - d. Cold water storage tanks.
 - e. Water softeners in exterior locations.
 - f. Duct mounted coils not factory insulated.
 - g. Roof drain bodies.
 - h. Air handling equipment parts that are not factory insulated.
 - i. Expansion and air separation tanks.
 - j. Converters.
 - k. Heat exchangers.

- I. Hot water generators.
 - m. Water heaters not factory insulated.
 - n. Hot water storage tanks not factory insulated.
 - 2. Insulation Type
 - a. Insulation shall be flexible elastomeric Cellular Insulation as specified for Pipe Insulation Systems. The insulation shall have the same thickness as the adjacent piping.
 - 3. Pump Insulation
 - a. Insulate pumps by forming the insulation around the pump housing to ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered. Joints between sides and between sides and bottom shall be joined by contact adhesive for flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.
 - 4. Other Equipment
 - a. Insulation shall be formed to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
 - b. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used.
- C. Equipment Exposed to Weather
- 1. Installation
 - a. Equipment exposed to weather shall be insulated and finished in accordance with the requirements for piping exposed to weather.

-- End of Section 23 07 00 --

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 – GENERAL

1.1 SUMMARY

- A. Provide a complete Direct Digital Control (DDC) system, suitable for the control of the heating, ventilating and air conditioning (HVAC) systems describe here and in Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. Provide HVAC Controls for all new equipment, equipment to be reused and controls for metering of gas, water and electrical utilities.
- B. GENERAL REQUIREMENTS
1. Provide new direct digital control (DDC) system and connect to and modify existing base DDC system including associated equipment and accessories. The DDC system shall be a complete system suitable for the heating, ventilating and air conditioning (HVAC) system. This direct digital (DDC) control system shall be fully 100% compatible with the existing base wide front-end Energy Monitoring and Control System (EMCS) currently installed on Goodfellow Air Force Base. This existing front-end EMCS system is manufactured by Automated Logic Corporation, Marietta, Georgia. Goodfellow AFB personnel will work with the DDC Controls Contractor on commissioning of the DDC Control System. Project graphic and function block development will be provided by the Contractor.
- C. Proprietary Systems
1. Proprietary Systems Exempted from Open Protocol Requirements
 2. The following systems are specifically exempted from the open protocol requirements:
 - a. Chiller / Boilers
 - b. Computer Room Air Conditioning Systems
 3. Implementation of Proprietary Systems
 - a. For proprietary systems exempted from open protocol requirements, a proprietary network and DDC hardware communicating via proprietary protocol are permitted. For these systems a building control network meeting the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC must also be provided, along with a gateway or interface to connect the proprietary system to the open building control network.
 - b. The proprietary system gateway or interface must provide the required functionality as shown on the points schedule. Scheduling, alarming, trending, overrides, network inputs, network outputs and other protocol related requirements must be met on the open protocol control system as specified in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
 - c. Related requirements must be met on the open protocol control system as specified in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
- D. System Requirements
1. Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:
 - a. The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment.
 - b. The system shall meet the requirements of this specification as a stand-alone system and shall communicate with the existing EMCS system.

- c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network, unless otherwise pre-approved by the Contracting Officer.
 - d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.
 - e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.
 - f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.
 - g. Hardware is installed and configured such that the Government or their agents are to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.
- E. End to End Accuracy
1. Select products install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.
- F. Verification of Dimensions
1. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.
- G. Drawings
1. The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

- A. Related work specified elsewhere:
1. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
 2. Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
 3. Section 23 09 93 SEQUENCES OF OPERATIONS FOR HVAC CONTROL

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. *All publications shall be the latest version/edition/revision of the documents listed below, in effect on the date of this solicitation, except where a date is given.*

UNIFIED FACILITIES CRITERIA (UFC)

DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

- A. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
 - ASHRAE FUN IP | Fundamentals Handbook, I-P Edition
 - ASHRAE 135 | Data Communication Protocol
- B. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
 - IEEE C62.41 | Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
- C. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
 - NEMA 250 | Enclosures for Electrical Equipment (1000 Volts Maximum)
- D. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
 - NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
 - NFPA 90A | Standard for the Installation of Air Conditioning and Ventilating Systems
- E. UNDERWRITERS LABORATORIES (UL)
 - UL 5085-3 | (2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 DEFINITIONS

- A. The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness. The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

1. Alarm Generation

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the destination (such as a user interface).

2. Building Automation and Control Network

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

3. BACnet Advanced Application Controller (B-AAC)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming but, is not required to support as many BIBBs as a B-BC.

4. BACnet Application Specific Controller (B-ASC)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

5. BACnet Building Controller (B-BC)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

6. BACnet Broadcast Management Device (BBMD)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

7. BACnet/IP

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

8. BACnet Internetwork

Two or more BACnet networks, connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

9. BACnet Interoperability Building Blocks (BIBBs)

A BIBB is a collection of one or more ASHRAE 135 Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

The following is a list of some BIBBs used by this or referenced Sections:	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)

The following is a list of some BIBBs used by this or referenced Sections:	
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

10. BACnet Network

In BACnet, a portion of the control Internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

11. BACnet Operator Display (B-OD)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

12. BACnet Segment

One or more physical segments interconnected by repeaters (ASHRAE 135).

13. BACnet Smart Actuator (B-SA)

A simple actuator device with limited resources intended for specific applications.

14. BACnet Smart Sensor (B-SS)

A simple sensing device with limited resources.

15. BACnet Testing Laboratories (BTL)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

16. BACnet Testing Laboratories (BTL) Listed

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile; in which case the listing indicates that the device supports the required capabilities for that profile or may be listed as "other".

17. Binary

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

18. Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

19. Building Control Network (BCN)

The network connecting all DDC Hardware within a building (or specific group of buildings).

20. Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

21. Commandable

See Overridable.

22. Commandable Objects

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.

23. Configurable

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

In a non-Niagara Framework BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:

- via BACnet services (including proprietary BACnet services)
- via hardware settings on the device

Note this is more stringent than the ASHRAE 135 definition.

24. Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

25. Device

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

26. Device Object

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

27. Device Profile

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135. Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

28. Digital Controller

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

29. Direct Digital Control (DDC)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

30. Field Point of Connection (FPOC)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

31. Gateway

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

32. IEEE 802.3 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

33. Internet Protocol (IP, TCP/IP, UDP/IP)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

34. Input/Output (I/O)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

35. I/O Expansion Unit
An I/O expansion unit provides additional point capacity to a digital controller
36. IP subnet
A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.
37. Local-Area Network (LAN)
A communication network that spans a limited geographic area and uses the same basic communication technology throughout.
38. Local Display Panels (LDPs)
A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.
39. MAC Address
Media Access Control address. The physical device address that identifies a device on a Local Area Network.
40. Master-Slave/Token-Passing (MS/TP)
Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.
41. Monitoring and Control (M&C) Software
The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.
42. Network Number
A site-specific number assigned to each network. This network number must be unique throughout the BACnet Internetwork.
43. Object
An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.
44. Object Identifier
A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a number). Object Identifiers must be unique within a device.
45. Object Instance
See paragraph OBJECT IDENTIFIER
46. Object Properties
Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

47. Operator Configurable

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For non Niagara-based BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

- a Writable Property of a Standard BACnet Object; or
- a Property of a Standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

48. Override

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

49. Packaged Equipment

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

50. Packaged Unit

See packaged equipment.

51. Performance Verification Test (PVT)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

52. Physical Segment (BACnet)

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

53. Polling

A device periodically requesting data from another device.

54. Points

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

55. Proportional, Integral, and Derivative (PID) Control Loop

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

56. Proprietary (BACnet)

Within the context of BACnet, any extension of or addition to object types, properties, PrivateTransfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above are proprietary Properties.

57. Protocol Implementation Conformance Statement (PICS) (BACnet)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

58. Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

59. Router

A device that connects two ASHRAE 135 networks and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a BACnet internetwork and to limit network traffic.

60. Standard BACnet Properties (BACnet)

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not proprietary. See Proprietary.

61. Standard BACnet Services (BACnet)

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

62. UMCS

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

63. UMCS Network

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

64. Writable Property (BACnet)

A Property is Writable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writable when the Out of Service Property is TRUE are not considered to be Writable.

1.5 PROJECT SEQUENCING

- A. TABLE II: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'FIO' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE II does not specify overall project milestone and completion dates; these dates are specified in the contract documents.

- B. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in GENERAL REQUIREMENTS, SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.
 - 1. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.
 - 2. Abbreviations: In TABLE II the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Product Data	
4	S	Pre-construction QC Checklist	
5	E	Install Building Control System	AAO #1 thru #4
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	ACO #6
8	S	Programming Software Configuration Software	ACO #6
9	S	Draft As-Built Drawings	ACO #6
10	S	Start-Up Testing Report	ACO #6
11	S	PVT Procedures	before schedule start of #12 and AAO #10
12	S,E	Execute PVT PVT Testing Activities	AAO #9 and #11 As indicated in PART 3 of this Section
13	S	PVT Report	ACO #12As indicated in PART 3 of this Section
14	S	Controller Application Programs Controller Configuration Settings	AAO #13
15	S	Final As-Built Drawings	AAO #13
16	S	O&M Instructions	AAO #15

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
17	S	Training Documentation	AAO #10 and before scheduled start of #18
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

A. Government approval is required for submittals with a "G" or "FIO" classification. Submittals not having a "G" or "FIO" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 for SUBMITTAL PROCEDURES:

B. SD-02 Shop Drawings

1. DDC Contractor Design Drawings; G
2. Final As-Built Drawings;

C. SD-03 Product Data

1. Programming Software; G
2. Controller Application Programs; G
3. Configuration Software; G

D. System Descriptions and Analyses; G

System descriptions, analyses, and calculations used in required sizing equipment. Descriptions and calculations shall show how the equipment will operate as a system to meet the specified performance. The data package shall include the following:

1. DDC panel memory size.
2. DDC panel automatic start up operations.
3. Database update procedure.
4. DDC panel expansion capability and method of implementation.
5. DDC panel operation.
6. Database entry forms or data listings.

E. Site Testing; G

Provide copies of the test procedures for the site testing. The site testing procedures shall identify each item to be tested and shall clearly describe each test. The test procedures shall include a list of the test equipment to be used for site testing, manufacturer and model number, and the date of calibration and accuracy of calibration, within 6 months of the test date.

SD-06 Test Reports

1. Existing Conditions Report
2. Start-Up Testing Report; G
3. PVT Procedures;
4. PVT Report;
5. Pre-Construction Quality Control (QC) Checklist;
6. Post-Construction Quality Control (QC) Checklist;
7. Enclosure Keys; G
8. Password Summary Report; G
9. Closeout Quality Control (QC) Checklist; G

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

- A. Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project, and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

- A. Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.
- B. Configuration Software
 1. For each type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. Submit hard and digital copies of the software user manuals for each software with the software submittal.
 2. Submit Configuration Software on CD-ROM as a Technical Data Package. Submit copies of the software user manual for each piece of software.
- C. Controller Configuration Settings
 1. For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
 2. Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2copies of the Controller Configuration Settings CD-ROM.

D. Programming Software

1. For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. Submit hard and digital copies of software user manuals for each software with the software submittal.
2. Submit Programming Software on CD-ROM as a Technical Data Package. Submit copies of the software user manual for each piece of software.

E. Controller Application Programs

1. For each programmable controller, provide copies of the application program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
2. Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST

- A. If requesting the use of a gateway to a boiler or chiller plant as indicated in paragraph Proprietary Systems Exempted from Open Protocol Requirements, submit a Boiler or Chiller Plant Gateway Request describing the configuration of the boilers or chillers including model numbers for equipment and controllers, the sequence of operation for the units, and a justification for the need to operate the units on network.

1.10 QUALITY CONTROL CHECKLISTS

- A. The QC Checklist for BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

1.11 The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1. Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit four copies of the Pre-Construction QC Checklist.

2. Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit four copies of the Post-Construction QC Checklist.

3. Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit four copies of the Closeout QC Checklist.

PART 2 – PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC for BACnet.

2.1 GENERAL PRODUCT REQUIREMENTS

- A. Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts, and components.

2.2 PRODUCT DATA

- A. Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.
- B. For all BACnet hardware: for each manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
- C. Submit Manufacturer's Product Data on CD-ROM.

2.3 OPERATION ENVIRONMENT

- A. Unless otherwise specified, provide products rated for continuous operation under the following conditions:
- a. Pressure: Pressure conditions normally encountered in the installed location.
 - b. Vibration: Vibration conditions normally encountered in the installed location.
 - c. Temperature:
 - Products installed indoors: Ambient temperatures in the range of 60 to 80 degrees F and temperature conditions outside this range normally encountered at the installed location.
 - Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of +20- to +120 degrees F and temperature conditions outside this range normally encountered at the installed location.
 - d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

- A. Contractor shall coordinate with the government to ensure the new EMCS system does not require wireless capability due to existing EMCS constraints. If wireless capability is not required, for products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. If wireless capability is required, ensure the wireless capabilities are operational for EMCS.

2.5 ENCLOSURES

- A. Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:
1. Outdoors
 - a. For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 4 requirements.
 2. Mechanical and Electrical Rooms
 - a. For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 4 requirements.
 3. Other Locations
 - a. For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

- A. Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.
- B. Terminal Blocks
- For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.
- C. Control Wiring for Binary Signals
- For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.
- D. Control Wiring for Analog Signals
- For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:
- a. minimum 2 inch lay of twist
 - b. 100 percent shielded pairs
 - c. at least 300-volt insulation
 - d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation
 - e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.
- E. Power Wiring for Control Devices
- For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.
- F. Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 – EXECUTION

3.1 EXISTING CONDITIONS

A. Existing Conditions Survey

1. Perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For those items considered nonfunctional, document the deficiency in the report including explanation of the deficiencies and estimated costs to correct the deficiencies. As part of the report, define the scheduled need date for connection to existing equipment. Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.
2. Submit four copies of the Existing Conditions Report.

B. Existing Equipment Downtime

1. Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

C. Existing Control System Devices

1. Inspect, calibrate, and adjust as necessary to place in proper working order all existing devices which are to be reused.

3.2 INSTALLATION

A. Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC for BACnet or Niagara BACnet systems, and this Section.

B. Dielectric Isolation

1. Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a manner that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

C. Penetrations in Building Exterior

1. Make all penetrations through and mounting holes in the building exterior watertight.

D. Device Mounting Criteria

1. Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weather shield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not interfere with the clearance requirements for mechanical and electrical system maintenance.

E. Labels and Tags

1. Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using

adhesive but must not be hand-written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

- a. Label all Enclosures and DDC Hardware.
- b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.
- c. Tag duct static pressure taps at the location of the pressure tap

F. Surge Protection

1. Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

2. Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

- A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.
- A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

G. Basic Cybersecurity Requirements

1. Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with COR. Provide a Password Summary Report documenting the password for each device and describing the procedure to change the password for each device.

Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

2. Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3. IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

3.3 DRAWINGS AND CALCULATIONS

- A. Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature, and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

- B. Submit hardcopy drawings on 17 by 11 inches sheets, and electronic drawings in PDF and in AutoCAD format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.
1. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 3 hard copies and 3 copies on CD-ROM.
 2. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: 3 hard copies and 3 copies on CD-ROM.
 3. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: 3 hard copies and 3 copies on CD-ROM.
- C. Sample Drawings
- Sample drawings in electronic format are available at the Whole Building Design Guide page for this section: <http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00> These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.
- D. Drawing Index and Legend
- Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.
- E. Thermostat and Occupancy Sensor Schedule
- Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.
- F. Valve Schedule
- Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access, and clearance requirements. Provide a single valve schedule for the entire project.
- G. Damper Schedule
- Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.
- H. Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

I. Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

J. Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

K. DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

BACnet Device Information

- Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

- Network Number

The Network Number for the device.

- MAC Address

The MAC Address for the device

- BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

- Proprietary Services Information

If the device uses non-standard ASHRAE 135 services as defined and permitted in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

a) read: interpret the data contained in the non-standard service
and;

b) write: given similar data, generate the appropriate non-standard service request.

- Alarming Information

Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

- Scheduling Information

Indicate whether the device is used for scheduling.

- Trending Information

Indicate whether the device is used for trending and indicate if the device is used to trend local values, remote values, or both.

L. Points Schedule

1. Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.
 - a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.
 - b. When Point Schedules are included in the contract package, items requiring Contractor verification or input have been shown in angle brackets (" $<$ " and " $>$ "), such as $< ___ >$ for a required entry or $< \text{value} >$ for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.
2. Points Schedule Columns must include:
 - a. Point Name

The abbreviated name for the point using the indicated naming convention.
 - b. Description

A brief functional description of the point such as "Supply Air Temperature".
 - c. DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.
 - d. Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.
 - e. Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.
 - f. Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

 - AI: The value comes from a hardware Analog Input

- AO: The value is output as a hardware Analog Output
- BI: The value comes from a hardware Binary Input
- BO: The value is output as a hardware Binary Output
- PULSE: The value comes from a hardware Pulse Accumulator Input
- NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.
- NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. Object and Property Information

The Object Type and Instance Number for the Object associated with the point. If the value of the point is not in the Present Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

h. Network Data Exchange Information (Gets Data From, Sends Data To)

Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

i. Trend Object Information

For each point requiring a trend, indicate if the trend is Local or Remote, the trend Object type and the trend Object instance number. For remote trends provide the DDC Hardware Identifier for the device containing the trend Object in the Points Schedule notes.

j. Alarm Information

Indicate the Alarm Generation Type, Event Enrollment Object Instance Number, and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have Event Enrollment Objects.)

k. Configuration Information

Indicate the means of configuration associated with each point.

l. Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

M. Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

N. Sequences of Operation - Including Control Logic Diagrams

Provide HVAC control system sequence of operation and control logic diagrams in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation and control logic diagrams for each HVAC system

O. Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.4 CONTROLLER TUNING

- A. Tune each controller in a manner consistent with that described in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.5 START-UP

A. Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

1. Systems Check

An item-by-item check must be performed for each HVAC system

- Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel to verify that all displays indicate shutdown conditions.

- Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology

standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

- Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

2. Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

- B. Start-Up Testing Report

Submit 4 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification and is ready for the Performance Verification Test (PVT).

- 3.6 PERFORMANCE VERIFICATION TEST (PVT)

- A. PVT Procedures

Prepare PVT Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

1. Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

2. Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously.

Use the building control system BACnet Trend Log or Trend Log Multiple Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

3. PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

- B. PVT Execution

1. Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

C. PVT Report

1. Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.
2. Submit digital copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.7 PERFORMANCE VERIFICATION TESTING

A. General

PVT testing must demonstrate compliance of controls work with contract document requirements and must be performed by the Controls Contractor and Equipment Suppliers. No less than 14 calendar days prior to start of controls system installation, meet with the Contracting Office's technical representative (COTR) and the designing engineer of the HVAC systems, the Contractor's QA representative, the Contractor's Controls Contractor representative, to develop a mutual understanding relate to the details of the PVT work requirements, including required submittals, work schedule, and field quality control.

B. Performance Verification Testing and Commissioning

PVT testing is a Government quality assurance function that includes systems trending and field tests. Commissioning is a quality control function that is the Commissioning Team's responsibility to the extent required by this contract.

C. Performance Verification Testing of Equipment with Packaged Controls

1. Controls Contractor and Equipment Supplier(s) must share and coordinate PVT testing responsibilities for equipment provided with on-board factory packaged controls such as boiler controllers, dedicated outside air systems (DOAS's), and packaged pumping systems.
2. Controls Contractor Responsibilities

The Controls Contractor must provide a PVT Plan separate from Equipment Supplier's performance verification testing plan, perform endurance testing, and perform PVT testing concurrent with Equipment Suppliers' testing for equipment provided with on-board factory packaged controls to demonstrate the following:

- a. Equipment enabling and disabling.
- b. Equipment standard and optional control points necessary to accomplish functionality regardless if specified in contract documents or not.
- c. Equipment standard and optional alarms critical to safe operation regardless if specified in contract documents or not.

- d. All control points added by Controls Contractor in addition to onboard factory packaged controls regardless if specified in contract documents or not.

Refer to paragraphs titled "Performance Verification Test Plan" and "Endurance Testing" for additional information.

3. Equipment Supplier Responsibilities

Each Equipment Supplier must provide PVT Plans separate from Controls Contractor's plans and perform PVT testing concurrent with Controls Contractor's testing for their equipment provided with on-board factory packaged controls to demonstrate the following:

- a. Equipment standard and optional control features necessary to accomplish functionality regardless if specified in contract documents or not.
- b. Equipment standard and optional operation modes necessary to accomplish functionality regardless if specified in contract documents or not.
- c. Equipment standard and optional alarm conditions for safe operation regardless if specified in contract documents or not.

Refer to all paragraphs under paragraph titled "Performance Verification Testing" except for section titled "Endurance Testing" for additional information.

D. Sequencing of Performance Verification Testing Activities

PVT activities must be sequenced with major activities listed below for Test and Balance (TAB) Contractor, Equipment Suppliers, Commissioning Specialists, and others to demonstrate fully functioning systems. Complete the items in TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES as schedule activities or milestones.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
1	Submission, review, and approval of Control Contractors PVT Plans.
2	Submission, review, and approval of Equipment Suppliers PVT Plans.
3	Submission, review, and approval of certified final Test and Balance Report.
4	Conduct commissioning functional performance tests.
5	Submission, review, and approval of all of the Commissioning Specialists completed functional performance tests.
6	Request Contracting Officer to allow beginning of Government-witnessed PVT testing.
7	Contracting Officers approval to begin PVT testing.
8	Conduct PVT field work.
9	Governments verbal approval of PVT field work for all systems.
10	Conduct Test and Balance verification field work.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
11	Governments written approval of Test and Balance verification fieldwork.
12	Submission, review, and approval of endurance testing.
13	Governments written approval of PVT field work for all systems.
14	Facility acceptance recommendation.
15	Submission, review, and approval of Control Contractors PVT Report.
16	Submission, review, and approval of Equipment Suppliers PVT Report.
17	Conduct applicable re-testing within 10 months of beneficial occupancy.

E. Control Contractor's Performance Verification Testing Plan

1. Submit a detailed PVT Plan of the proposed control systems testing in this contract for approval prior to its use. Develop and use a single PVT Plan for each system with a unique control sequence. Systems sharing an identical control sequence can be tested using copies of the PVT Plan intended for these systems.
2. PVT Plans must include system-based, step-by-step test methods demonstrating system performs in accordance with contract document requirements. The Government may provide sample PVT Plans upon request. PVT Plans must include the following:
 - a. Control sequences from contract documents segmented such that each control algorithm, operation mode, and alarm condition is immediately followed by numbered test methods required to initiate a response, expected response, space for comments, and "pass" or "fail" indication for each expected response.
 - b. PVT Plans with control sequences from contract documents that are not segmented into parts will not be accepted.
 - c. Indication where assisting personnel are required such as Mechanical Contractor.
 - d. Signature and date lines for the Contractor's PVT administrator, Contractor's quality assurance representative, and Contracting Officer's representative acknowledging completion of testing.

F. Performance Verification Testing Sample Size

PVT testing sample sizes will be as follows:

- a. 100-Percent of the following systems:
 - primary systems including, but not limited to, chilled water and HVAC heating hot water systems
 - air handling unit systems including all associated fans except for remote exhaust air fans
 - DOAS's including all associated fans except for remote exhaust air fans

- b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:
 - air terminal units
 - exhaust air fans
 - terminal equipment such as fan coil units and unit heaters
2. Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

 - a. An additional 25-percent after five-percent failure rate of first sample set.
 - b. 100-percent after any failures occurring in additional sample set.
- G. Conducting Performance Verification Testing
 1. At least 15 days prior to preferred test date, request the Contracting Officer to allow the beginning of Government-witnessed PVT testing. Provide an estimated time table required to perform testing of each system. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of testing. Testing personnel must be regularly employed in the testing and calibration of control systems. After receipt of Contracting Officer's approval to begin testing, perform PVT testing using project's as-built (shop) control system drawings, project's design drawings, and approved PVT Plans.
 2. During testing, identify deficiencies that do not meet contract document requirements. Deficiencies must be investigated, corrected with corrections documented, and re-tested at a later date following procedures for the initial PVT testing. The Government may require re-testing of any control system components affected by the original failed test.
- H. Endurance Testing
 1. General
 - a. Conduct endurance testing in conjunction with the PVT to demonstrate control loop stability and accuracy. For all control loops tested, record trend data of the control variables over time, demonstrating that the control loop responds to a sudden change of the control variable set point without excessive overshoot or undershoot. Conduct endurance testing for each system subject to PVT testing. Systems must be operating as normally anticipated during occupancy throughout endurance testing.
 - b. Endurance testing results must clearly demonstrate control loop stability and accuracy. Controlled loop outputs must be stable and accurately maintain each setpoint.
 2. Hardware
 - a. Use hardware provided in this contract for testing.
 - b. If insufficient buffer capacity exists to trend the entire endurance test, upload trend data during the course of endurance testing to ensure all trend data is retained. Lost trend data will require retesting of all control points for affected system(s).
 3. Endurance Testing Results Format
 - a. Submit endurance testing results for each tested system in a graphical format complete with clear indication of value(s) for y-axis, value for x-axis, and legend identifying each trended control point. The number of control points contained on a single graph must be such that all

control points can be clearly visible. Control points must be logically grouped such that related points appear on a single graph. In addition, submit a separate comma separated value (CSV) file of raw trend data for each trended system. Each trended control point in CSV file must be clearly identified.

- b. For control points recorded based on change of value, change of value for recording data must be clearly identified for each control point.
4. Endurance Testing Start, Duration, and Frequency
 - a. Trending of all control points for a given system must start at an identical date and time regardless of the basis of data collection. Duration of all endurance tests must be at least one-week.
 - b. Unless specified otherwise for control points recorded based on time, frequency of data collection must be 15-minutes. Frequency of data collection for specific types of control points is as follows:
 - c. Points Trended at One Minute Intervals
 - Temperature for supply air, return air, mixed air, supply water, and return water
 - Temperature for outside air, supply air, return air and exhaust air entering and leaving energy recovery device
 - Flow for supply air, return air, outside air, chilled water, and HVAC heating hot water
 - Flow for exhaust air associated with energy recovery
 - Relative humidity for outside air and return air
 - Relative humidity for outside air, supply air, return air and exhaust air entering and leaving energy recovery device
 - Command and status for control dampers and control valves
 - Speed for fans and pumps
 - Pressure for fans and pumps
 - d. Points Trended at 15 Minute Intervals
 - Temperature and relative humidity for zones
 - Temperature and relative humidity for outside air not associated with energy recovery
 - Command and status for equipment
 - Pressure relative to the outside for facility
 5. Trended Control Points
 - a. Trended control points for each system must demonstrate each system performs in accordance with contract document requirements. Trended control points must include, but not be limited to, control points listed in contract document points list.
 - b. Minimum control points that are required to be trended for selected systems are listed below. These control points must be trended as applicable to this contract in addition to control points necessary to demonstrate systems perform in accordance with contract document requirements and those listed in contract document's points list.

- c. Air-Cooled Chiller Chilled Water System.
 - Water-Chiller(s) command and status
 - Chiller isolation valve(s) command and status
 - Chilled water pump(s) actual speed
 - Chilled water pump(s) setpoint and actual differential pressure
 - Minimum flow bypass control valve command
 - Minimum system flow setpoint and actual flow
 - Chilled water supply setpoint and actual temperature
 - Chilled water return actual temperature
 - Chilled water actual flow
 - Outside air actual dry-bulb temperature

- d. HVAC Heating Hot Water System with Boiler.
 - Boiler(s) command and status
 - Boiler(s) isolation valve command and status
 - HVAC heating hot water pump(s) actual speed
 - HVAC heating hot water pump(s) setpoint and actual differential pressure
 - Minimum flow bypass control valve command
 - Minimum system setpoint and actual flow
 - HVAC heating hot water supply setpoint and actual temperature
 - HVAC heating hot water return actual temperature
 - HVAC heating hot water actual flow
 - Outside air actual dry-bulb temperature

- e. HVAC Heating Hot Water System
 - HVAC heating hot water pump(s) actual speed
 - HVAC heating hot water pump(s) setpoint and actual differential pressure
 - Minimum flow bypass control valve command
 - Minimum system setpoint and actual flow
 - HVAC heating hot water supply setpoint and actual temperature
 - HVAC heating hot water return actual temperature

- HVAC heating hot water actual flow
 - Outside air actual dry-bulb temperature
- f. Air Handling Unit with Relief Air Fan
- Outside air actual dry-bulb temperature
 - Outside air actual relative humidity
 - Outside air setpoint and actual airflow
 - Minimum outside air control damper command
 - Facility setpoint and actual relative pressure
 - Return air actual dry-bulb temperature
 - Return air actual relative humidity
 - Return air control damper command
 - Relief air control damper command
 - Relief air fan actual speed
 - Mixed air setpoint and setpoint and actual temperature
 - Cooling coil leaving air setpoint and actual temperature
 - Cooling coil control valve command
 - Supply air fan actual speed
 - Discharge air actual temperature
 - Supply air fan setpoint and actual static pressure
- g. Dedicated Outside Air System (DOAS)
- Outside air actual dry-bulb temperature
 - Outside air actual relative humidity
 - Outside air isolation damper command and status
 - Outside air setpoint and actual airflow
 - Energy recovery unit's OA discharge air actual dry-bulb temperature
 - Energy recovery unit's OA discharge air actual relative humidity
 - Cooling coil leaving air setpoint and actual temperature
 - Cooling coil control valve command
 - Supply air fan actual speed

- Discharge air setpoint and actual temperature
- Supply air fan setpoint and actual static pressure
- Facility setpoint and actual relative pressure
- Return air actual dry-bulb temperature
- Return air actual relative humidity
- Energy recovery unit's EA discharge air actual dry-bulb temperature
- Energy recovery unit's EA discharge air actual relative humidity
- Exhaust air fan actual speed
- Exhaust air isolation damper command and status

h. Fan-Coil Units

- Zone setpoint and actual dry-bulb temperature
- Zone actual relative humidity
- FCU- Fresh Air Control damper command
- Fan command and status
- Heating coil valve command
- Leaving air actual temperature

6. Endurance Testing Sample Size

a. Endurance Testing sample sizes were as follows:

100-Percent of the following systems:

- primary systems including, but not limited to, chilled water and HVAC heating hot water systems
- fan coil unit systems including all associated valves, supply air damper, associated room exhaust air damper
- DOAS's including all associated fans

b. Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

- An additional 25-percent after five-percent failure rate of first sample set.
- 100-percent after any failures occurring in additional sample set.

I. Performance Verification Test Report

- a. Submit a PVT Report after receiving Government's written approval of PVT field work that is intended to document test results and final control system sequences and settings prior to turnover. The PVT Report must contain the following:
- b. Executive summary that briefly discusses results of each system's endurance testing and PVT testing and conclusions for each system.
- c. Endurance testing for each system.
- d. Completed PVT Plan for each system used during testing that includes hand written field notes and participant signatures.
- e. Blank PVT Plan for each system approved prior to testing that is edited to reflect changes occurring during testing. Edits must be typed and must reflect changes to control sequences from contract documents, must reflect changes to numbered test methods required to initiate a response, and must reflect changes to expected response. Only one blank PVT Plan is required for each set of systems sharing an identical control sequence, such as air terminal units, exhaust air fans, fan coil units and unit heaters.
- f. Written certification that the installation and testing of all systems are complete and meet all contract document requirements.

3.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

- A. Provide HVAC control System Operation and Maintenance Instructions which include:
 - a. OPERATION AND MAINTENANCE DATA for each piece of control equipment.
 - b. HVAC control system sequences of operation formatted as indicated.
 - c. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
 - d. As-built HVAC control system detail drawings formatted as indicated.
 - e. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.
 - f. Qualified service organization list, including at a minimum company name, contact name and phone number.
 - g. Start-Up Testing Report.
 - h. Performance Verification Test (PVT) Procedures and Report.
- B. Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

3.9 NOT USED.

3.10 TRAINING

- A. Conduct a training course for operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 32 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment) of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of

classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

1. Training Documentation

Prepare training documentation consisting of:

- a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the Controls, HVAC and,Electrical shop supervisor.
- b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

2. Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3. Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

QC CHECKLIST FOR BACNET SYSTEMS		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (_) verifying that the requirement has been met.		
This checklist is for (circle one): Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	_
2	Signal lines on Control System Schematic are labeled with the signal type.	_
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	_
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	_
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	_
Items verified for Closeout QC Checklist Submittal:		
6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	_
7	Programming software has been submitted for all programmable controllers.	_
8	All software has been licensed to the Government.	_
9	O&M Instructions have been completed and submitted.	_
10	Training course has been completed.	_

QC CHECKLIST FOR BACNET SYSTEMS		
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	<input type="checkbox"/>
12	All DDC Hardware is BTL listed.	<input type="checkbox"/>
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	<input type="checkbox"/>
14	Scheduling, Alarming, and Trending have been implemented using the standard BACnet Objects for these functions.	<input type="checkbox"/>
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	<input type="checkbox"/>
<p>_____</p>		
	(QC Representative Signature)	(Date)

-- End of Section 23 09 00 --

SECTION 23 09 13 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" or "FIO" classification. Submittals not having a "G" or "FIO" classification are for information only. Submit the following in accordance with Section 01 33 00 GENERAL REQUIREMENTS:

A. SD-02 Shop Drawings

Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences.

Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

B. SD-03 Product Data

Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

C. SD-05 Design Data

Manufacturer's Instructions: Provide for all manufactured components.

D. SD-08 Manufacturer's Instructions

Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

E. SD-10 Operation and Maintenance Data

Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

Revise shop drawings to reflect actual installation and operating sequences

1.2 QUALITY CONTROL

A. Qualifications

1. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State in which the Project is located.
2. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Automated Logic.

2.2 EQUIPMENT

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.3 COMPONENTS

A. CONTROL PANELS

1. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
2. NEMA 250, general purpose utility enclosures with enameled finished face panel. Provide common keying for all panels.

B. CONTROL VALVES

1. Globe Patterns
 - a. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - b. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 - c. Hydronic Systems:
 - Rate for service pressure of 125 psig at 250 degrees F.
 - Replaceable plugs and seats of stainless steel.
 - Size for 3 psig maximum pressure drop at design flow rate.
 - Two-way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two-way valve operators to close valves against pump shut off head.
2. Butterfly Pattern
 - a. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
 - b. Hydronic Systems:
 - Rate for service pressure of 125 psig at 250 degrees F.
 - Size for 1 psig maximum pressure drop at design flow rate.
3. Electronic Operators
 - a. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 - b. Select operator for full shut off at maximum pump differential pressure.

C. DAMPERS

- a. Manufacturers:
 - Ruskin: www.ruskin.com.
 - Greenheck: www.greenheck.com.
 - Substitutions: Approved or Equal
- b. Performance: Test in accordance with AMCA 500-D.
- c. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch.
- d. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
- e. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- f. Jamb Seals: Spring stainless steel.
- g. Shaft Bearings: Oil impregnated sintered bronze.
- h. Linkage Bearings: Oil impregnated sintered bronze.
- i. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.

- j. Maximum Pressure Differential: 6 inches wg.
- k. Temperature Limits: Minus 40 to 200 degrees F.

1. Damper Operators

- a. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - Provide one operator for maximum 36 sq ft damper section.
- b. Electric Operators:
 - Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.
 - On/Off or 2-Position:
 - Power: 24 VAC.
 - Position Feedback: Dry contact.
 - Stroke Duration: 60 seconds, adjustable.
 - Proportional (Modulated):
 - Input: 0 to 10 VDC.
 - External Power: 12 VDC.
 - Position Feedback: 0 to 10 VDC.
 - Stroke Duration: 60 seconds.

D. HUMIDISTAT

- 1. Room Humidistats:
 - a. Wall mounted, proportioning type.
 - b. Throttling Range: Adjustable 2 percent relative humidity.
 - c. Operating Range: 30 to 80 percent.
 - d. Maximum Temperature: 110 degrees F.
 - e. Cover: Set point indication.
- 2. Limit Duct Humidistats:
 - a. Insertion, two position type.
 - b. Throttling Range: Adjustable 2 percent relative humidity.
 - c. Operating Range: 20 to 80 percent.
 - d. Maximum Temperature: 150 degrees F.

E. Input/Output Sensors

1. Temperature Sensors

Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.

Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers. Temperature Sensing Device: Compatible with project DDC controllers.

Performance Characteristics:

- a. RTD:
 - Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - Range: Minus 40 degrees F through 220 degrees F minimum.
- b. Thermistor:

- Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - Range: Minus 25 degrees F through 122 degrees F minimum.
 - Heat Dissipation Constant: 2.7 mW per degree C.
- c. Temperature Transmitter:
- Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - Output: 4 to 20 mA.
- d. Sensing Range:
- Provide limited range sensors if required to sense the range expected for a respective point.
 - Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
- e. Wire Resistance:
- Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - Compensate for wire resistance in software input definition when feature is available in the DDC controller.
- f. Room Sensors: Locking cover matching the pneumatic thermostats used.
- g. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
- h. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
- i. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.
- j. Room Temperature Sensors with Integral Digital Display:
- Construct for surface or wall box mounting.
 - Provide a four button keypad with the following capabilities:
 - Indication of space temperatures.
 - Setpoint adjustment to accommodate room setpoint and DDC
 - Input/Output Points List.
 - Manual occupancy override and indication of occupancy status.
 - Controller mode status.
 - Room sensors shall be capable of receiving separator heating and cooling set points from the BAS during unoccupied periods.
 - Communication port for portable operator interface.
- k. Temperature Averaging Elements:
- Use on duct sensors for ductwork 10 sq ft or larger.
 - Use averaging elements where prone to stratification with sensor length 8 ft, or 16 ft.
 - Provide for all mixed air and heating coil discharge sensors regardless of duct size.
- l. Insertion Elements:
- Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
2. Humidity Sensors
- a. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
- Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
 - Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.

- Output Voltage Type: 3-wire observed polarity.
 - Output mA Type: 2-wire, not polarity sensitive (clipped and capped).
 - Humidity:
 - HS Element: Digitally profiled thin-film capacitive.
 - Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multi- point calibration, NIST traceable.
 - Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multi- point calibration, NIST traceable).
 - Scaling: 0 to 100 percent RH.
 - Temperature Effect:
 - Duct Mounted: Plus/minus 0.18 percent per degree F.
 - Outdoor Mounted: 4 to 20mA version: $(0.0013 \times \%RH \times (T_{\text{degreeC}} - 25))$.
 - Hysteresis: 1.5 percent typical.
 - Linearity: Included in accuracy specification.
 - Reset Rate: 24 hours.
 - Stability: Plus/minus 1 percent at 68 degrees F (20 degrees C) annually, for two years.
 - Temperature Monitoring:
 - Temperature Transmitter Output: Digital, 4 to 20mA (clipped and capped) or 0- 5V/0- 10V output.
 - HO Transmitter Accuracy: Plus/minus 2.3 degrees F.
 - HD Transmitter Accuracy: Plus/minus 1.0 degree F.
 - Operating Environment:
 - Operating Humidity Range: 0 to 100 percent RH noncondensing.
 - Operating Temperature Range: - 40 degrees F to 122 degrees F.
 - Wall Mounted Sensor: Voltage type encased in a plastic housing
3. Static Pressure (Air Pressure) Sensors
- a. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 - b. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - c. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - d. Output: 0 to 5 vdc with power at 12 to 28 vdc.
4. Equipment Operation (Current) Sensors
- a. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 - b. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 - c. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
5. Damper Position Indicators
- Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.Text
6. Carbon Dioxide Sensors, Duct and Wall

- a. General: Provide non-dispersive infrared (NDIR), diffusion sampling CO2 sensors with integral transducers and linear output.
- b. Air Temperature: Range of 32 to 122 degrees F.
- c. Relative Humidity: Range of 0 to 95 percent (non-condensing).
- d. Power Input: Class 2; 12 to 30VDC or 24VAC 50/60 Hz; 100mA max.
- e. Calibration Characteristics:
 - Automatically compensating algorithm for sensor drift due to sensor degradation.
 - Maximum Drift: 2 percent.
 - User calibratable with a minimum calibration interval of 5 years.
- f. Construction:
 - Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
 - Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
 - Housing: High impact plastic.
- g. Optional Equipment
 - Temperature Sensor:
Solid state, integrated circuit; Accuracy: Plus/minus 1 degree F; Resolution: 0.2 degrees F; Output Range: 50 to 95 degrees F.

F. THERMOSTATS

1. Electric Room Thermostats:
 - a. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
 - b. Service: Cooling and heating.
 - c. Covers: Locking with set point adjustment, with thermometer.
2. Room Thermostat Accessories:
 - a. Thermostat Covers: White plastic.
 - b. Insulating Bases: For thermostats located on exterior walls.
 - c. Thermostat Guards: Metal mounted on separate base.
 - d. Adjusting Key: As required for device.
 - e. Aspirating Boxes: Where indicated for thermostats requiring flush installation.
3. Immersion Thermostats:
 - a. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
4. Airstream Thermostats:
 - a. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 - b. Averaging service remote bulb element: 7.5 feet.
5. Electric Low Limit Duct Thermostats:
 - a. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,
 - b. Bulb length: Minimum 20 feet.
 - c. Provide one thermostat for every 20 sq ft of coil surface.
6. Electric High Limit Duct Thermostats:
 - a. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,
 - b. Bulb length: Minimum 20 feet.
 - c. Provide one thermostat for every 20 sq ft of coil surface.

G. TRANSMITTERS

1. Building Static Pressure Transmitters:
One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
2. Pressure Transmitters:
One pipe direct acting indicating type for gas, liquid, range suitable for system, proportional electronic output.
3. Air Pressure Transmitters:

General: Provide dry media differential pressure transducers to monitor duct and room pressure.

- a. Media Compatibility: Dry air.
- b. Input Power: Class 2; 12 to 30 VDC; 2-wire: 20 mA max.
- c. Output: Field selectable, 2-wire, loop-powered 4 to 20 mA (DC only, clipped and capped).
- d. Pressure Ranges: 4 and 7, field selectable.
- e. Response Time:
 - Standard: T95 in 20 seconds.
 - Fast: T95 in 2 seconds.
 - Switch selectable.
- f. Mode: Switch selectable, unidirectional.
- g. Display:
 - Signed 3-1/2 digit LCD, indicates pressure.
 - Over-range indicator.
- h. Proof Pressure (pressure differential): 3 psid.
- i. Burst Pressure (pressure differential): 5 psid.
- j. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).
- k. Temperature Effect (per transmitter size):
 - 1 inch w.c.: 2.0 percent per degree C.
 - 10 inch w.c.: 0.01 percent per degree C.; (Relative to 25 degrees C) 32 degrees F to 122 degrees F.
- l. Zero Drift (1-year) (per transmitter size):
 - 1 inch w.c.: 2 percent maximum.
 - 10 inch: 0.05 percent maximum.
- m. Zero adjust: Pushbutton auto-zero and digital input (2-pos terminal block).
- n. Operating Environment:
 - 32 degrees F to 140 degrees F.
 - 0 to 90 percent RH noncondensing.
- o. Fittings:
 - Brass barb.
 - 0.24 inches outer diameter.
 - UL 94 V-O fire retardant ABS.

4. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):

General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow remote pressure sensing capability using existing plumbing runs.

- a. Input Power: Class 2; 15 to 30 VDC, 24VAC nominal, 50/60 Hz.
 - b. Maximum Current Draw:
 - DC: 125 mA.
 - AC: 280 mA.
 - c. Output: 3-wire transmitter; user-selectable, 4 to 20 mA (0 to 5V/0 to 10V).
 - d. Sensor:
 - Media Compatibility: 17 to 4 PH stainless steel.
 - Status Indication: Dual color LED.
 - Proof Pressure: 2x max. F.S. range.
 - Burst Pressure: 5x max. F.S. range.
 - Accuracy at 77 degrees F for less than or equal 20 ft:
 - Ranges A and B: Plus/minus 1 percent F.S. typical.
 - Range C: Plus/minus 1.5 percent F.S. typical.
 - Range D: Plus/minus 2 percent F.S. typical.
 - Surge Damping: Electronic; 1 second averaging.
 - Long Term Stability: Plus/minus 0.25 percent.
 - Zero Offset (Bidirectional and Port Swap Modes Only): 0.5 percent.
 - e. Reverser:
 - Zero Adjust: Push button auto-zero and digital input (2-position terminal block).
 - Fittings:
 - 27 NPT female thread, stainless steel 17 to 4 PH.
 - f. Pressure Ranges:
 - 0 psi to 50 psi (Gauge): 5 psid/10 psid/25 psid/50 psid (pressure differential).
 - 0 psi to 100 psi (Gauge): 10 psid/20 psid/50 psid/100 psid (pressure differential).
 - 0 psi to 250 psi (Gauge): 25 psid/50 psid/125 psid/250 psid (pressure differential).
 - g. Operating Conditions:
 - Temperature Compensated Range:
 - 32 degrees F.
 - TC Zero less than 1.5 percent of product F.S. (full scale) per sensor.
 - TC Span less than 1.5 percent of product F.S. (full scale) per sensor.
 - Sensor Operating Range: Minus 4 degrees F to 185 degrees F.
 - Operating Environment: 14 degrees F to 122 degrees F; 10 to 90 percent RH noncondensing.
 - h. Enclosure: NEMA 250, Type 4.
5. Temperature Transmitters:
One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degrees F span, with 50 degrees F. temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.
6. Humidity Transmitters:
One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

H. FLOW SENSORS

1. Venturi Tubes:
 - a. Fabricate the venturi tube from cast iron with an accuracy of plus/minus 1 percent of full flow.
 - b. Line the throat section with austenitic stainless steel.
 - c. Thermal Expansion Characteristics of the Lining: Same as that of the throat casting material.
 - d. Machine the surface of the throat to plus/minus 50 micro-inches including the short curvature leading from the converging entrance section into the throat.
2. Airflow Measurement Array (AFMA):
 - a. Airflow Straighteners:
 - Provide AFMA's with an airflow straightener if required by the AFMA manufacturer's published installation instructions.
 - In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA.

- Straightener: Contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendations of the AFMA manufacturer.
 - Construction to consist of 0.125 inch aluminum honeycomb with the straightener depth not less than 1.5 inches.
 - b. Outdoor Air Temperature: In outside air measurement or in low-temperature air delivery applications, provide an AFMA certified by the manufacturer to be accurate as specified over a temperature range of minus 20 degrees F to 120 degrees F.
 - c. Airflow Resistance:
 - Resistance to Airflow Through the AFMA and the Airflow Straightener: Not to exceed 0.085 inches at an airflow velocity of 2000 fpm.
 - AFMA Construction: Suitable for operation at air flows of up to 5000 fpm over a temperature range of 40 degrees F to 120 degrees F.
 - d. Pitot Tube:
 - Furnish each pitot tube AFMA with an array of velocity sensing elements.
 - Velocity Sensing Elements: Multiple pitot tube type with averaging manifolds.
 - Distribute the sensing elements across the duct section in the pattern and quantity specified or as recommended by the installation instructions of the AMFA manufacturer.
 - Pitot Tube AFMA's in Air Flows Over 600 fpm: Accuracy of plus/minus 5 percent over a range of 500 fpm to 2500 fpm.
 - Pitot Tube AFMA's in Air Flows Under 600 fpm: Accuracy of plus/minus 5 percent over a range of 125 fpm to 2500 fpm.
 - e. Electronic:
 - Each electronic AFMA to consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type.
 - Sensing Elements: Distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the manufacturer.
 - Electronic AFMA's: Accuracy of plus/minus 5 percent over a range of 125 fpm to 5,000 fpm and temperature compensated output over a range of 32 degrees F to 212 degrees F.
 - Fan Inlet Measurement Devices: Refer to drawings and/or equipment schedules.
3. Annular Pitot Tubes:
- a. Fabricate the annular pitot tube from austenitic stainless steel with an accuracy of plus/minus 2 percent of full flow and a repeatability of plus/minus 0.50 percent of measured value.
 - b. Unit to have at least one static port with no less than four total head pressure ports with an averaging manifold.
4. Insertion Turbine Flow Meters:
- a. Furnish dual axial turbine flowmeter with all installation hardware required to enable insertion and removal of the meter without system shutdown.
 - b. All Parts: Meet or exceed the pressure classification of the piping system installed in.
 - c. Accuracy for the Insertion Turbine Flow Meter: Plus/minus 0.5 percent of the rate at calibrated velocity, within plus/minus of the rate over a 10 to 1 turn down and within plus/minus 2 percent of the rate over a 50 to 1 turn down.
 - d. Repeatability: Plus/minus 0.25 percent of reading.
 - e. The meter flow sensing element to operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate.
 - f. Include dry contact outputs, 4 to 20 mA, 0 to 10 VDC.
 - g. Fabricate the turbine rotor assembly of Series 300 stainless steel and use Teflon seats.
5. Flow Switches:
- a. Repetitive Accuracy: Plus/minus 10 percent of actual flow setting.
 - b. Switch Actuation: Adjustable over the operating range and sized for the application, such that the setpoint is between 25 and 75 percent of the full range.
 - c. Provide Form C snap-action contacts, rated for the application.
 - d. Furnish non-flexible paddle with magnetically actuated contacts, rated for service at a pressure greater than the installed conditions.
 - e. Flow Switch for Use in Sewage Systems: Rated for use in corrosive environments encountered.

I. ROOM PRESSURATIION MONITOR

1. Furnish and install room pressure/airflow direction monitors as manufactured by TSI Company, model Pressure at locations called for and shown on the drawings.
2. Each monitor shall have the following features and characteristics:
 - a. A indicator consisting of an emergency-powered electric alarm warning of improper directional airflow, alarm to be initiated by industrial-grade photo eye detection of reversal of position of visual indicator.
 - b. A local wall-mounted annunciator with mute and test features indicating status of system power as well as audible and visual notification of an abnormal airflow/pressurization condition. Mute and test shall be accomplished using a horn silence switch and test button illuminating all lights and sounding the horn.
 - c. Provide a remote alarm at the nurse station where shown on the drawings.
3. Provide each monitor with a 115 volt pre-wired controller to provide interface between photo eye and local annunciator. Controller shall include an integral time delay relay with an adjustable 0 to 60 second interval to allow for transient events such as door opening without the triggering of nuisance alarms.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 3'-10" above floor. Align with lighting switches and humidistats.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide low ambient control for refrigerant system.
- F. Provide separable sockets for liquids and flanges for air bulb elements.
- G. Provide thermostats in aspirating boxes in front entrances.
- H. Provide guards on thermostats in entrances.
- I. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- J. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors.
- K. Provide isolation (two position) dampers of parallel blade construction.
- L. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- M. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- N. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- O. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.3 *Control System Calibration, Adjustments, and Commissioning*

Instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, shall be adjusted before the system is placed on line. Communications requirements shall be as indicated. Control system commissioning shall be performed for each HVAC system. The report describing results of functional tests, diagnostics, and calibrations, including written certification, shall state that the installed complete system has been calibrated and tested.

A. *Coordination with HVAC System Balancing*

The HVAC control system shall be tuned after all air-system and hydronic-system balancing has been completed, minimum damper positions set and a report issued. Commissioning may be performed prior to or simultaneous with HVAC system balancing.

3.4 *Posted Instructions*

Instructions on letter size sheets and half size plastic laminated drawings for each system, showing the final installed conditions, shall be placed in each HVAC control panel at each mechanical room. The posted instructions shall include the control sequence, control schematic, ladder diagram, wiring diagram, valve schedules, damper schedules, commissioning procedures, and preventive maintenance instructions.

3.5 *TRAINING*

The training course shall be conducted for 4 operating staff members designated by the Contracting Officer in the maintenance and operation of the system, including specified hardware and software. No training shall be scheduled until training manuals and O&M manuals have been approved by the Government.

A. *Training Course Content*

The course shall be taught at the project site. The training course shall cover the material contained in the Operating and Maintenance Instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.6 *MAINTENANCE*

Provide service and maintenance of control system for one year from Date of Beneficial Occupancy. Provide complete service of controls systems, including call backs, and submit written report of each service call.

-- End of Section 23 09 13 --

SECTION 23 09 23.02 - BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTALS

A. Data

1. Product Data

Provide data for each system component and software module.

B. Shop Drawings

1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
4. Indicate description and sequence of operation of operating, user, and application software.

C. Manufacturer's Instructions

Indicate manufacturer's installation instructions for all manufactured components.

D. Project Record Documents

1. Record actual locations of control components, including control units, thermostats, and sensors.
 - a. Revise shop drawings to reflect actual installation and operating sequences.
 - b. Include submittals data in final "Record Documents" form

E. Operation and Maintenance Data

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Final copies of the manuals bound in hardback, loose leaf binders, within 30 days after completing the test. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The draft copy used during site testing shall be updated with any changes required, prior to final submission of the manual. The final copies delivered after completion of the test shall include modifications made during installation checkout and acceptance. Manuals shall include:
 5. Functional Design Manual
Provide copies of the functional design manual which shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.
 6. Software Manual; GA
Provide copies of the software manual which shall describe the functions of all software, and shall include all other information necessary to enable proper loading, testing and operation including, but not limited to the following:

- a. Definitions of terms and functions.
- b. Operator commands.
- c. System access requirements.
- d. Data entry requirements.
- e. Descriptions of application software.
- f. Description of database structure and interface with programs.
- g. Alarms.

7. Operator's Manual

Provide copies of operation manuals for each HVAC control system, in booklet form and indexed, outlining the step by step procedures required for each HVAC control system's startup, operation, and shutdown. The manuals shall include detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment.

8. Warranty

Submit manufacturer's warranty and ensure forms have been filled out in Government's name and registered with manufacturer.

1.2 DELIVERY AND STORAGE

- A. Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.3 QUALITY CONTROL

- A. Perform work in accordance with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.
- C. Verify that products were installed per manufacturer's instructions.

1.4 WARRANTY

- A. Correct defective Work within a five year period after Substantial Completion. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.5 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Government acknowledges a software license agreement with provisions for the following:
 1. Limiting use of software to equipment provided under these specifications.
 2. Limiting copying.
 3. Preserving confidentiality.
 4. Prohibiting transfer to a third party.

1.6 INSTALLATION

- A. Designate flow stations flow stations, flow probes, pipe wells, pressure sensor tips, valves, dampers, meters, actuators, and related accessories for installation by applicable installers in accordance with Division 23 requirements.

- B. Designate power meters, current sensors, current switches, and related accessories for installation by applicable installers in accordance with Division 26 requirements.
- C. Raceways, Cable and Wires: Install per NECA 1 following project proposed or pre-defined routes. Field verify and ensure that installed items will not inhibit access to any device or limit service clearances of nearby equipment.
- D. Identification: Identify and tag installed components as follows:
 - 1. Panels:
 - a. Door: Fasten a 1-1/4 inch blue nameplate tag with 1 inch white characters.
 - b. Sub-panel Items: Apply a 1/2 inch adhesive tag suitable for damp harsh environment with 1/4 inch black characters per item. Identify and tag remote electrical panel/breaker panel feed and remote data closet with switch port as well.
 - 2. Raceway, Cable and Wires: Comply with Section 26 20 00. Tag each cable or conductor with both hardware and software tags when different. Include the power supply voltage only on the conductors powering the end device. Label hardwired interlocks as "Safety Interlocks".
- E. Passive Sensors Signal Adjustment: Measure and add sensor wiring resistance to controller input definition settings to ensure accurate temperature readings.
- F. Control Schematics: Provide wall-fastened laminated copy of related drawings such as schematics, wiring diagrams, schedules, and sequences of operation per system or equipment.

1.7 CLEANING

- A. Execute housekeeping measures by keeping work areas neat, clean all the time.

1.8 COMMISSIONING

- A. Commissioning (Cx): Release equipment or system to Commissioning Agent (CxA) to schedule formal functional tests.

1.9 CLOSEOUT ACTIVITIES

- A. Training: Train Government's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two - 4 hour sessions of training

1.10 MAINTENANCE

- A. Clean, adjust, lubricate, and calibrate devices, sensors, panels, and thermostats

PART 2 PRODUCTS

- A. All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project.
- B. Nameplates and Tags: Nameplates bearing legends as shown and tags bearing device unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to Direct Digital Control (DDC) panel interior doors. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

2.1 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for Mechanical Controls Called Equipment and Systems called out in Section 23 09 23 and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.2 OPERATOR INTERFACE

- A. PC Based Work Station:
 - 1. Resides on high speed network with building controllers.
 - 2. Connected to server for full access to all system information.
 - 3. Language: English
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol and certification to comply with ASHRAE Std 135.
- D. Hardware:
 - 1. Desktop:
 - a. Control system shall be updated to the most current version that is compatible with existing front end.
 - b. Software must have an application life and compatibility with future systems for at least 5 years. If a new version is released and approved for use on Air Force networks within 12 months of system commissioning, the Contractor shall provide install and commission an update to the most recent version without additional cost to the Government.

2.3 CONTROLLERS

A. BUILDING CONTROLLERS

1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol
2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - Mount within waterproof enclosures.
 - Rated for operation at minus 4 to 140 degrees
 - b. Conditioned Space:
 - Mount within dustproof enclosures.
 - Rated for operation at 32 to 120 degrees F.
4. Local Keypad and Display for each Controller
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use
5. Provisions for Serviceability
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours
7. Power and Noise Immunity
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. CUSTOM APPLICATION CONTROLLERS

1. General:

- a. Provide sufficient memory (minimum flash memory capacity: 128 GB) to support controller's operating system, database, and programming requirements. Memory Card Interface Type: SD, SHOC or SXDC
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling. Network - synchronized
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 - h. Silenceable, audible Alarm notification: Piezoelectric sounder.
Timed password auto-lock feature.
2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - Mount within waterproof enclosures.
 - Rated for operation at minus 4 to 140 degrees F.
 - b. Conditioned Space:
 - Mount within dustproof enclosures.
 - Rated for operation at 32 to 120 degrees F.
 4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use. Downloaded or field configured.
 5. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

C. APPLICATION SPECIFIC CONTROLLERS

1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:

- Mount within waterproof enclosures.
- Rated for operation at minus 4 to 140 degrees F.
- b. Conditioned Space:
 - Mount within dustproof enclosures.
 - Rated for operation at 32 to 120 degrees F.
- 4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
- 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

D. AIR HANDLING/DOAS AND ENERGY RECOVERY UNIT CONTROLLER

- 1. Inputs: 8-binary (configurable) and 4-analog (configurable).
- 2. Outputs: 8-binary (configurable) and 4-analog (configurable).
- 3. Display: Graphics-based terminal device in compliance with requirements.
- 4. Peripheral Communications: Proprietary data bus over screw terminal block.
- 5. Memory: 16 Mb non-volatile battery-backed with a 32-bit memory bus.
- 6. Accessories:
 - a. Duct temperature sensors, humidity sensor, differential pressure sensors etc. as noted on drawings. Provide occupancy override, and occupancy sensor in compliance with requirements.
 - b. T-Stat Connectivity: Cable harness, 75 ft.
 - c. Accessories: Transformers, on-off switch, relays, transducers, vinyl-metallic adhesive identification tags, and programming software.
- 7. Mounting:
 - a. Factory: Ship to air handling unit manufacturer-prescribed compartment.
 - b. Equipment: Control panel or manufacturer-prescribed compartment.
 - c. Field: Provide a control panel complying with NEMA 250 and UL 50 or UL 50E use in non-hazardous locations with:
 - Enclosure: Minimum size of 24 by 24 inch with key-lockable, lever-type door handle suitable use for on:
 - Indoors and Plenums: NEMA 250, Type 1.
 - Mechanical Rooms: NEMA 250, Type 2, using any mounting orientation.
 - Outdoors: NEMA 250, Type 4 or Type 4X with built-in heaters for extreme ambient conditions.
 - Rear panel door document pocket with a minimum size of ½ inch.
 - Wire ducts sized to cover exposed wire runs.
 - d. Blank Space: Include a 20 percent internal space allowance for incidentals.
 - e. Self-supporting Structure: Provide metal channel (strut) framing system and related hardware to mount box on the floor or wall end next to equipment.

E. SPARE CAPACITY

Include a 10 percent object (point) allowance for incidentals

F. WIRE CONNECTIONS

Device to feature removable wire terminals.

G. CONTROL SEQUENCES

Based on ASHRAE RP-1455 for airside applications and ASHRAE Std 90.1 I-P for waterside applications.

H. COMMUNICATIONS PROTOCOL

BACnet MS/TP per ASHRAE Std 135

I. CERTIFICATION

BACnet Testing Laboratory (BTL) certified device listed under the BACnet Application Specific Controller (B-ASC) device profile in compliance with ASHRAE Std 135.

J. INPUT/OUTPUT INTERFACE

Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.

1. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties
2. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
3. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
4. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
5. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
6. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
7. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - Fan coil units.

- DOAS - Room Supply and Exhaust Air Dampers.
- c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- 8. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.4 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 - 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 - 2. Limit connected loads to 80 percent of rated capacity.
 - 3. Match DC power supply to current output and voltage requirements.
 - 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 - 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 - 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 - 7. Operational Ambient Conditions: 32 to 120 degrees F.
 - 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
 - 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
 - 1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 - 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.5 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN). LAN Capacity: Not less than 60 stations or nodes. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration. LAN Data Speed: Minimum 19.2 Kb. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- B. Transmission Median: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.
- C. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6 SYSTEM SOFTWARE

- A. Operating System
 - 1. Concurrent, multi-tasking capability:
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: Web CTRL
 - 2. System Graphics
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:

- Move between, change size, and change location of graphic displays.
 - Modify on-line.
 - Add, delete, or change dynamic objects consisting of:
 - Analog and binary values.
 - Dynamic .
 - Static .
 - Animation files.
3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - Chillers.
 - Boilers.
 - Air Handlers.
 - Fan Coil Units.
 - b. Ancillary Equipment:
 - Fans.
 - Pumps.
 - Coils.
 - Valves.
 - Piping.
 - Dampers.
 - Ductwork.
 - c. File Format Compatible with Graphics Generation Package Program.
- B. Workstation System Applications
1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user- adjustable, time period.
 - f. All system security data stored in encrypted format.

6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - Workstations.
 - Printers.
 - Modems.
 - Network connections.
 - Building management panels.
 - Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - Alarm limits.
 - Alarm limit differentials.
 - States.
 - Reactions for each object.
8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - Source.
 - Location.
 - Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics
10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - Sampled and stored on the building controller panel.
 - Archivable on hard disk.
 - Retrievable for use in reports, spreadsheets and standard database programs.
 - Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - Menu.
 - Graphics.
 - Custom Programs

13. Reports and Logs:
 - a. Reporting Package:
 - Allows operator to select, modify, or create reports.
 - Definable as to data content, format, interval, and date.
 - Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc..
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s)

14. Reports:
 - a. Standard:
 - Objects with current values.
 - Current alarms not locked out.
 - Disabled and overridden objects, points and SNVTs.
 - Objects in manual or automatic alarm lockout.
 - Objects in alarm lockout currently in alarm.
 - Logs:
 - Alarm History.
 - System messages.
 - System events.
 - Trends.
 - b. Custom:
 - Daily.
 - Weekly.
 - Monthly.
 - Annual.
 - Time and date stamped.
 - Title.
 - Facility name.
 - c. Tenant Override:
 - Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - Annual report showing override usage on a monthly basis.
 - d. Daily Operating Condition of Chiller(s) Based on ASHRAE Std 147:
 - Chilled water inlet and outlet temperature.
 - Chilled water flow.
 - Chilled water inlet and outlet pressure.
 - Evaporator refrigerant pressure and temperature.
 - Condenser refrigerant pressure and temperature.
 - Condenser refrigerant pressure and liquid temperature.
 - Refrigerant levels.
 - Oil pressure and temperature.
 - Oil level.
 - Compressor refrigerant discharge temperature.
 - Refrigerant suction temperature.
 - Motor amperes per phase.
 - Motor volts per phase.
 - Ambient temperature (dry-bulb and wet-bulb).
 - Date and time logged.

- C. Workstation Applications Editors
 1. Provide editing software for each system application at PC workstation.
Downloaded application is executed at controller panel.
Full screen editor for each application allows operator to view and change:

- a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
2. Scheduling:
- a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
3. Custom Application Programming:
- a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - Support for conditional statements IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.7 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 3. Holiday or Special Schedules:

- a. Capability to define up to 99 schedules.
- b. Repeated annually.
- c. Length of each period is operator defined.

Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

D. Alarms:

1. Binary object is set to alarm based on the operator specified state.
2. Analog object to have high/low alarm limits.
3. All alarming is capable of being automatically and manually disabled.
4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
 - Start programs.
 - Print.
 - Logged.
 - Custom messaging.
 - Graphical displays.
 - Dial out to workstation receivers via system protocol.

E. Demand Limiting:

1. Building power consumption monitored from signals generated by a pulse generator, mounted at the building power meter.
2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner.
3. Demand Reduction Methods:
 - a. Supply air temperature reset.
 - b. Space temperature set-point reset.
 - c. Equipment off/on prioritization.
4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.
5. Operator On-Line Changes Allowed:
 - a. Addition and deletion of loads controlled.
 - b. Changes in demand intervals.
 - c. Changes in demand limit for meter(s).
 - d. Maximum equipment shutoff time.
 - e. Minimum equipment shutoff time.
 - f. Select rotational or sequential shedding and restoring.
 - g. Shed/restore priority.
6. Information and Reports available Hourly, Daily, and Monthly:
 - a. Total electric consumption.
 - b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.

H. PID Control Characteristics:

1. Direct or reverse action.
2. Anti-windup.
3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
4. User selectable controlled variable, set-point, and PED gains.

Staggered Start Application:

 - a. Prevents all controlled equipment from simultaneously restarting after power outage.
 - b. Order of equipment startup is user selectable.

5. Energy Calculations:
 - a. Accumulated instantaneous power or flow rates are converted to energy use data.
 - b. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 - c. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- I. Anti-Short Cycling:
 1. All binary output objects protected from short-cycling.
 2. Allows minimum on-time and off-time to be selected.
- J. On-Off Control with Differential:
 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- K. Run-Time Totalization:
 1. Totalize run-times for all binary input objects.
 2. Provides operator with capability to assign high run-time alarm.

2.8 HVAC CONTROL PROGRAMS

- A. General:
 1. Support Inch-pounds and SI (metric) units of measurement.
 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 4. Use outside air temperature to determine early shut down with ventilation override.
 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
 6. Operator commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run time control summary.
 - i. Request optimal run time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
 7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run time system normal start times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
 8. Mass temperature summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.

9. HVAC point summary:
 - a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and point.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Enthalpy Switchover:
 1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
 2. Operator commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.
 - c. Add/delete discharge controller point.
 - d. Define discharge controller parameters.
 - e. Add/delete return air temperature point.
 - f. Add/delete outside air dew point/humidity point.
 - g. Add/delete return air dew point/humidity point.
 - h. Add/delete damper switch.
 - i. Add/delete minimum outside air.
 - j. Add/delete atmospheric pressure.
 - k. Add/delete heating override switch.
 - l. Add/delete evaporative cooling switch.
 - m. Add/delete air flow rate.
 - n. Define enthalpy deadband.
 - o. Lock/unlock program.
 - p. Request control summary.
 - q. Request HVAC point summary.
 3. Control summary:
 - a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Optimal return time system status.
 - d. Current outside air enthalpy.
 - e. Calculated mixed air enthalpy.
 - f. Calculated cooling coil enthalpy using outside air.
 - g. Calculated cooling coil enthalpy using mixed air.
 - h. Calculated enthalpy difference.
 - i. Enthalpy switchover deadband.
 - j. Status of damper mode switch.

2.9 CHILLER CONTROL PROGRAMS

- A. Control function of condenser water reset, chilled water reset, and chiller sequencing. Support inch-pounds and SI (metric) units of measurement. Condenser Water Reset: Automatically reset controlled condenser water temperature using measured outside wet bulb temperature and load being handled. Chilled Water Reset: Automatically reset controlled chilled water temperature satisfying cooling coil requiring greatest cooling. Chiller Sequencing: Determine which combination of chillers will most efficiently satisfy chilled water load, by cycling chillers, based on comparing load to switchover limits defined for each chiller.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, is installed prior to installation proceeding.

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit. Provide conduit and electrical wiring in accordance with Section 26 20 00. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation. Provide service engineer to instruct CO's representative in operation of systems plant and equipment for 3 day period. Provide basic operator training on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.4 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to CO.

3.5 MAINTENANCE

- A. See Section 01 10 10 Closeout & Warranty, for additional requirements relating to maintenance service, provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports. Provide complete service of systems, including call backs. Make complete normal inspections in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.6 SCHEDULES

- A. Input/Output Schedule
 - 1. Point Description:
 - 2. Digital Input:
 - a. Auxiliary Contact;
 - b. Switches:
 - Switch Closing;
 - Flow Switch;
 - Optical;
 - c. Current;
 - d. Pressure;
 - 3. Digital Output:
 - a. Control Relay;
 - b. Solenoid;
 - c. Contactor;
 - 4. Analog Input:
 - a. Temperature;
 - b. Relative Humidity;
 - c. Pressure/Vacuum;
 - d. Filter;
 - e. Flow;
 - f. Current;
 - g. Liquid Level;
 - 5. Analog Output:
 - a. 4-20 ma Module;

- b. 0-16 v DC;
- 6. Alarm

B. Input/Output Schedule

- 1. Point Description:
- 2. Inputs:
 - a. Temperature;
 - b. Relative Humidity;
 - c. Pressure;
 - d. Flow;
 - e. Position:
- 3. Outputs:
 - a. Status;
 - b. Alarm;
 - c. Electronic Position;
 - d. Set Point Adjust;
 - e. Start/Stop;
 - f. Off/Low/High;
- 4. Software Features:
 - a. PID Control (DDC);
 - b. High Limit;
 - c. Low Limit;
 - d. Run Time Totalization;
 - e. Consumption Totalization;
 - f. Program Start/Stop;
 - g. Optimal Run Time;
 - h. O.A. Interlock;
 - i. O.A. Temperature Reset;
 - j. Free Cooling Mode;
 - k. Warm-up Mode;
 - l. Boiler Interlock;
 - m. Chiller Sequencing.

C. Alarm Schedule

- 1. High Limit: A1.
- 2. Low Limit: A2.
- 3. Run Time: A3.
- 4. Maintenance: A4.
- 5. Status: A5.
- 6. Override: A6.
- 7. Freeze: A7.
- 8. Low Pressure: A8.

-- End of Section 23 09 23.02 --

SECTION 23 09 93 - SEQUENCES OF OPERATION FOR HVAC CONTROL

PART 1 - GENERAL

1.1 DEFINITIONS

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified here and on the drawings. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. DOAS Energy Recovery Unit
 - 2. Air terminal units/DOAS Supply Air
 - 3. Room Exhaust Air/DOAS Return Air
 - 4. Heat Pump
 - 5. Fan coil units.
 - 6. Heating coils.
 - 7. Unit heaters.
 - 8. Exhaust Fan Systems

1.2 SUBMITTALS

- A. Submittals related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.
- B. Sequence of Operation Documentation:

Submit written sequence of operation for entire HVAC system and each piece of equipment.

- 1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
- 2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in the contract documents.
- 3. Include at least the following sequences:
 - a. Start-up.
 - b. Warm-up mode.
 - c. Normal operating mode.
 - d. Unoccupied mode.
 - e. Shutdown.
 - f. Capacity control sequences and equipment staging.
 - g. Temperature and pressure control, such as setbacks, setups, resets, etc.
 - h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - i. Effects of power or equipment failure with all standby component functions.
 - j. Sequences for all alarms and emergency shut downs.
 - k. Seasonal operational differences and recommendations.
 - l. Interactions and interlocks with other systems.
- 4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
- 5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.
- 6. Include schedules, if known.

- C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
1. Label with settings, adjustable range of control and limits.
 2. Include flow diagrams for each control system, graphically depicting control logic.
 3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 5. Include all monitoring, control and virtual points specified in elsewhere.
 6. Include a key to all abbreviations.
- D. Points List: Submit list of all control points indicating at least the following for each point.
1. Name of controlled system.
 2. Point abbreviation.
 3. Point description; such as dry bulb temperature, airflow, etc.
 4. Display unit.
 5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
 6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
 7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
 8. Calculated point (Yes / No); i.e. a "virtual" point generated from calculations of other point values.
 9. Operator's Manual; G

Provide copies of operation manuals for each HVAC control system, in booklet form and indexed, outlining the step by step procedures required for each HVAC control system's startup, operation, and shutdown. The manuals shall include detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment.

- E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.
- F. QUALITY CONTROL

Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.

PART 2 - PRODUCTS

- A. Products related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and related Sections 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and 23 09 23.02 BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC

PART 3 - EXECUTION

Not Used

-- End of Section 23 09 93 --

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Pressure regulators. Indicate pressure ratings and capacities.
 - 4. Dielectric fittings.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

- A. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Aboveground Manual Gas Shutoff Valve Schedule" Article for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [A.Y. McDonald Mfg. Co.](#)
 - b. [Conbraco Industries, Inc.](#)
 - c. [Perfection Corporation.](#)
 2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [A.Y. McDonald Mfg. Co.](#)
 - b. [Lee Brass Company.](#)
 2. Body: Bronze, complying with ASTM B 584.
 3. Plug: Bronze.
 4. Ends: Threaded, socket, or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Operator: Square head or lug type with tamperproof feature where indicated.
 6. Pressure Class: 125 psig.
 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [A.Y. McDonald Mfg. Co.](#)
 - b. [Milliken Valve Company.](#)
 - c. [Mueller Co.](#)
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [A.Y. McDonald Mfg. Co.](#)

- b. [Watts: a Watts Water Technologies company.](#)
- c. [Zurn Industries, LLC.](#)

- 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Capitol Manufacturing Company.](#)
 - b. [Watts: a Watts Water Technologies company.](#)
 - c. [Wilkins.](#)
- 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

- 1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Advance Products & Systems, Inc.](#)
 - b. [Central Plastics Company.](#)
 - c. [Pipeline Seal and Insulator, Inc.](#)
- 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.6 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Verify final equipment locations for roughing-in.
- K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- M. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- O. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described

in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 00 00 "Plumbing General Purpose".
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 00 00 "Plumbing General Purpose".
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 00 00 "Plumbing General Purpose".

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 2. Cut threads full and clean using sharp dies.
 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.

3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 22 00 00 "Plumbing General Purpose".
- A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 22 00 00 "Plumbing General Purpose" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (gloss).
 - d. Color: Gray.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, in return air plenum or exposed in finished areas, shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full-port, bronze ball valves with bronze trim.
 - 3. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, lubricated plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

END OF SECTION 231123

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-03 Product Data
 - a. Refrigerant Piping System
2. SD-06 Test Reports
 - a. Refrigerant Piping Tests

1.2 QUALITY ASSURANCE

- A. Contract Drawings
1. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

PART 2 - PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

- A. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years prior to bid opening.
- B. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.
- C. System components shall be environmentally suitable for the indicated locations.
- D. Exposed equipment moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

2.2 REFRIGERANT PIPING SYSTEM

- A. Refrigerant piping, valves, fittings, and accessories shall be in accordance with ANSI/ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of

the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

2.3 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

A. Copper Tubing

1. Copper tubing shall conform to ASTM B280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

B. Solder

1. Solder shall conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

C. Brazing Filler Metal

1. Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 PIPING ACCESSORIES

A. Filter Driers

1. Driers shall conform to AHRI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

B. Sight Glass and Liquid Level Indicator

1. Assembly and Components
 - a. Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.
2. Bull's-Eye and Inline Sight Glass Reflex Lens
 - a. Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.
3. Moisture Indicator
 - a. Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

C. Pipe Hangers, Inserts, and Supports

1. Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

D. Escutcheons

1. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split

pattern, held in place by internal spring tension or set screws.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. After becoming familiar with all details of the work, perform a verification of dimensions in the field.

3.2 INSTALLATION

- A. Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

- B. Directional Changes

- 1. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

- C. Functional Requirements

- 1. Piping shall slope 1/2 inch/10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

- D. Fittings and End Connections

- 1. Threaded Connections

- a. Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

- 2. Brazed Connections

- a. Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Piping shall be supported prior to brazing and not be sprung or forced.

- E. Filter Dryer

- a. A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

- F. Sight Glass

- a. A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

G. Pipe Hangers, Inserts, and Supports

1. Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.
2. Hangers
 - a. Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
3. Inserts
 - a. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.
4. C-Clamps
 - a. Type 19 and 23 C-clamps shall be torqued in accordance with MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
5. Angle Attachments
 - a. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
6. Saddles and Shields
 - a. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.
7. Horizontal Pipe Supports
 - a. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.
8. Vertical Pipe Supports
 - a. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet not more than 8 feet from end of risers, and at vent terminations.
9. Multiple Pipe Runs
 - a. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

10. Structural Attachments

- a. Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section.

H. Building Surface Penetrations

1. Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth.
2. Refrigerated Space
 - a. Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar. Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than 4 inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.
3. General Service Areas
 - a. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.
4. Waterproof Penetrations
 - a. Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.
 - Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.
 - Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and

sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

5. Fire-Rated Penetrations

- a. Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

6. Escutcheons

- a. Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

I. Access Panels

1. Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced.

J. Field Applied Insulation

1. Field installed insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.3 CLEANING AND ADJUSTING

- A. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer. Water shall not be used in any procedure or test.

3.4 REFRIGERANT PIPING TESTS

- A. After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.
- B. Preliminary Procedures
 1. Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall

be removed and openings capped or plugged.

C. Pneumatic Test

1. Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ANSI/ASHRAE 15 & 34 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

D. Evacuation Test

1. Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

E. System Charging and Startup Test

1. Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

F. Refrigerant Leakage

1. If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

G. Contractor's Responsibility

1. At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

-- End of Section 232300 --

SECTION 23 30 00 - HVAC AIR DISTRIBUTION

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 within the text by the basic designation only. References shall be the latest edition on the date of solicitation.

ASME INTERNATIONAL (ASME)

ASME A13.1	Scheme for the Identification of Piping Systems
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UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	Building Materials Directory
UL 6	Electrical Rigid Metal Conduit-Steel
UL 181	UL standard for Safety Factory-Made Air Ducts and Air Connectors
UL 705	UL Standard for Safety Power Ventilators

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B766	Standard Specification for Electrodeposited Coatings of Cadmium
ASTM E2016	Standard Specification for Industrial Woven Wire Cloth
ASTM C665	Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM A924/A924M	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1654	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D3359	Standard Test Methods for Rating Adhesion by Tape Test
ASTM D520	Zinc Dust Pigment
ASTM C553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

ASTM A53/A53M

Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82

Protection of Stratospheric Ozone

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1

Motors and Generators

NEMA MG 10

Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1819

Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems

SMACNA 1966

HVAC Duct Construction Standards Metal and Flexible

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1

Ventilation for Acceptable Indoor Air Quality

ASHRAE 90.1 – IP

Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 70

Method of Testing the Performance of Air Outlets and Air Inlets

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A

Standard for the Installation of Air Conditioning and Ventilating Systems

NFPA 701

Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D

Laboratory Methods of Testing Dampers for Rating

AMCA 500-L

Laboratory Methods of Testing Louvers for Rating

AMCA 210

Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMCA 201

Fans and Systems

AMCA 300

Reverberant Room Method for Sound Testing of Fans

AMCA 301

Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings

1.2 SYSTEM DESCRIPTION

- A. Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.
- B. Mechanical Equipment Identification
 - 1. The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.
- C. Service Labeling
 - 1. Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - 1
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - 1
VAV Box Number	VAV - 1
Fan Coil Unit Number	FC - 1
Terminal Box Number	TB - 1
Unit Ventilator Number	UV - 1

- 2. Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:
 - a. Each point of entry and exit of pipe passing through walls.
 - b. Each change in direction, i.e., elbows, tees.
 - c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.
 - d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels must be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

D. Color Coding

1. Color coding of all piping systems must be in accordance with ASME A13.1 or MIL-STD-101.

1.3 SUBMITTALS

A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-02 Shop Drawings Detail
 - a. Drawings
2. SD-03 Product Data
 - a. Flexible Duct
 - b. Fire DamperS
 - c. Manual Balancing Dampers
 - d. DiffuserS
 - e. Registers and Grilles
 - f. Louvers
 - g. Ceiling Exhaust Fans
3. SD-06 Test Reports Performance
 - a. Tests
4. SD-07 Certificates
 - a. Ozone Depleting Substances
Technician Certification
5. SD-08 Manufacturer's Instructions
 - a. Manufacturer's Installation Instructions Operation and
Maintenance Training
6. SD-10 Operation and Maintenance Data
 - a. Operation and Maintenance Manuals;
7. SD-11 Closeout Submittals
 - a. Indoor Air Quality During Construction;

1.4 QUALITY ASSURANCE

- A. Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.
1. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.
 2. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.
 3. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.
 4. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at <http://femp.energy.gov/procurement>.
- B. Prevention of Corrosion
1. Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations.
- C. Asbestos Prohibition
1. Do not use asbestos and asbestos-containing products.
- D. Ozone Depleting Substances Technician Certification
1. All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants to include:
 - a. Proof of Technical Certification.
 - b. Proof of Equipment Certification for recovery or recycling equipment.
 - c. Proof of availability of certified recovery or recycling equipment.
- E. Detail Drawings
1. Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

F. Test Procedures

1. Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 - PRODUCTS

2.1 STANDARD PRODUCTS

- A. Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 STANDARD PRODUCTS

- A. Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers.
1. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.
 2. Prior to this two year period, these standard products must have been sold on the commercial market using advertisements in manufacturers' catalogs or brochures. These manufacturers' catalogs, or brochures must have been copyrighted documents or have been identified with a manufacturer's document number.
 3. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.3 IDENTIFICATION PLATES

- A. In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates that are 1-1/2-inches high and smaller must be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high must be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.4 EQUIPMENT GUARDS AND ACCESS

- A. Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section 08 31 00 ACCESS DOORS AND PANELS.

2.5 ELECTRICAL WORK

- A. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.
- B. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.
- C. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.
- D. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.
- E. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors.

2.6 ANCHOR BOLTS

- A. Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.7 SEISMIC ANCHORAGE

- A. Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.8 PAINTING

- A. Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved by Contracting Officer. Otherwise, return equipment to the factory for refinishing.

2.9 INDOOR AIR QUALITY

- A. Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.10 DUCT SYSTEMS

- A. Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

- a. Construct ductwork meeting the requirements for the duct system static pressure specified in APPENDIX D of Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.
- b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of

the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

- c. Provide ductwork that meets the requirements of Seal Class A.
- d. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table). Provide validation of indoor air quality for duct sealants.
- e. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.
- f. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

1. Metallic Flexible Duct

- a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 2 inches water gauge positive and 1.5 inches water gauge negative. Provide flexible round duct length that does not exceed 5 feet. Secure connections by applying adhesive for 2 inches over rigid duct, apply flexible duct 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.
- b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.
- c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2. General Service Duct Connectors

- a. Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

B. Duct Access Doors

- 1. Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

C. Manual Balancing Dampers

1. Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

D. Automatic Balancing Dampers

1. Provide dampers as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

E. Air Supply And Exhaust Air Dampers

1. Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:
 - a. ATFP Compliant dampers: the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 3 cfm per square foot of damper area and non-motorized dampers are not allowed.
 - b. All others: maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

F. Diffusers, Registers, and Grilles

1. Provide factory-fabricated units of aluminum that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.
2. Diffusers
 - a. Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.
3. Registers and Grilles
 - a. Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise

indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

4. Louvers
 - a. Provide louvers for installation in exterior walls that are associated with the air supply, exhaust, and distribution system as shown on the plans and plan schedules. Louvers are to be as indicated, testing in accordance with AMCA 500L for wind driven rain. Louvers shall be of aluminum construction with a minimum of 39% free area. Provide louvers with barometric and automatic dampers where indicated on plan and with bird screens. Finish is to match the building color and to anodized or fluoropolymer type.
5. Bird Screens and Frames
 - a. Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.11 AIR SYSTEMS EQUIPMENT

A. Fans

1. Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 120 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.
2. In-Line Centrifugal Fans
 - a. Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide motors with explosion-proof enclosure.
3. Ceiling Exhaust Fans
 - a. Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper.

Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Provide U.L. listed fans. Provide PL-109-58 labeled ceiling exhaust fan product. Provide proof of PL-109-58 label for ceiling exhaust fan product.

2.12 TERMINAL UNITS

A. Variable Air Volume (VAV), Single Duct Terminal Units

1. Provide variable volume, single duct, terminal units with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Provide units that control air volume to within plus or minus five percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. Provide units with an internal resistance not exceeding 0.4 inch water gauge at maximum flow range. Provide external differential pressure taps separate from the control pressure taps for air flow measurements with a 0 to 1 inch water gauge range.
2. Casing must be 22 gauge galvanized. The interior surface of the unit casing is acoustically and thermally lined with 1-inch, 1.5 lb/ft³ density glass fiber with foil facing. The insulation R-Value is 4.1. The insulation is UL listed and meets NFPA-90A and UL 181 standards as well as bacteriological standard ASTM C 665. There are no exposed edges of insulation (complete metal encapsulation).
3. The primary air inlet connection is an 18 gauge galvanized steel cylinder sized to fit standard round duct. A multiple-point, averaging flow sensing ring is provided with balancing taps for measuring +/-5% of unit cataloged airflow. An airflow-versus-pressure differential calibration chart is provided. The damper blade is constructed of a closed-cell foam seal that is mechanically locked between two 22-gauge galvanized steel disks. The damper blade assembly is connected to a cast zinc shaft supported by self-lubricating bearings. The shaft is cast with a damper position indicator. The valve assembly includes a mechanical stop to prevent over-stroking. At 4.0 in. w.g., air valve leakage does not exceed 1% of cataloged flow.
4. Provide factory installed 3-wire, 24-VAC, floating-point control actuator with linkage release button. Torque is 35 in-lb minimum and is non-spring return with a 90-second drive time. Travel is terminated by end stops at fully-opened and closed positions. An integral magnetic clutch eliminates motor stall.
5. Provide microprocessor based terminal unit controlled using pressure independent control through the use of a proportional integral control algorithm and direct digital control technology. The controller must be BACNET compatible.

2.13 FACTORY PAINTING

- A. Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.
- B. Field paint factory painting that has been damaged prior to acceptance by the Contracting Officer in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.14 SUPPLEMENTAL COMPONENTS/SERVICES

A. Refrigerant Piping

1. The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

B. Condensate Drain Lines

1. Provide and install condensate drainage for each item of equipment that generates condensate. Piping shall be socket welded schedule 40 PVC piping.
- C. Backflow Preventers
 1. The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.
- D. Insulation
 1. The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.
- E. Controls
 1. The requirements for controls are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

1. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.
 2. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.
- A. Condensate Drain Lines
 1. Provide water seals in the condensate drain from all units. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.
 - B. Equipment and Installation
 1. Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.
 - C. Access Panels
 1. Install access panels for concealed valves, vents, controls, dampers, and items requiring

inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced.

D. Flexible Duct

1. Install pre-insulated metallic flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

E. Metal Ductwork

1. Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

F. Dust Control

1. To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

G. Insulation

1. Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

H. Duct Test Holes

1. Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

I. Power Transmission Components Adjustment

1. Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

- A. Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 14 calendar days before being loaded.

3.4 CUTTING AND PATCHING

- A. Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

- A. Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical

equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

- A. Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.
- B. Sleeves
 - 1. Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.
- C. Framed Prepared Openings
 - 1. Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.
- D. Insulation
 - 1. Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.
- E. Closure Collars
 - 1. Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.
- F. Firestopping
 - 1. Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

- A. Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.
- B. Temperatures less than 120 degrees F

1. Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.
 - C. Temperatures between 120 and 400 degrees F
 1. Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.
 - D. Temperatures greater than 400 degrees F
 1. Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.
 - E. Color Coding Scheme for Locating Hidden Utility Components
 1. Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 3/8 inch diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks follow completion of the finished surface on which the disks are to be fastened. Provide color code board that is approximately foot wide, 30 inches high, and 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1/16 inch transparent plastic cover. Make the color code symbols approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount the color code board in the mechanical or equipment room. Make the color code system as directed by the Contracting Officer.
- 3.8 IDENTIFICATION SYSTEMS
- A. Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.
- 3.9 DUCTWORK LEAK TESTS
- A. The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.
- 3.10 DAMPER ACCEPTANCE TEST
- A. Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.
- 3.11 TESTING, ADJUSTING, AND BALANCING
- A. The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.
- 3.12 PERFORMANCE TESTS
- A. Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

3.13 CLEANING AND ADJUSTING

- A. Inside of equipment: thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.14 OPERATION AND MAINTENANCE

- A. Operation and Maintenance Manuals
 - 1. Submit six manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data
- B. Operation And Maintenance Training
 - 1. Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total working time sufficient to cover all equipment and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section 233000--

SECTION 23 36 00.00 40 - AIR TERMINAL UNITS

PART 1 - GENERAL

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

1.1 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communication, and partition assemblies.

1.2 SUBMITTALS

- A. Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-03 Product Data
 - a. Shutoff Single-Duct Air Terminal Units
2. SD-06 Test Reports
 - a. Operational Test Report
3. SD-07 Certificates
 - a. List of Spare Parts
4. SD-10 Operation and Maintenance Data
 - a. Operation and Maintenance Manuals
5. SD-11 Closeout Submittals
 - a. Record Drawings

1.3 QUALITY CONTROL

- A. Indicate on drawings the size, profiles, and dimensional requirements of air terminal units that are based on the specific system indicated.
- B. Conform to NFPA 70, Article 100 for electrical components, devices, and accessories. List and label items as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- 1.4 Ensure Air Terminals are certified under the AHRI 880 I-P Certification Program and carry the ARI Seal.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Verification of Performance
 1. Rate air terminal units according to AHRI 880 I-P.
- B. Shutoff Single-Duct Air Terminal Units
 1. Configuration

- a. Provide a volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

2. Casing

- a. Provide 0.034-inch casing. Ensure the casing includes an integral mixing baffle to efficiently mix the hot and cold airstream.
 - Casing Lining
 - Provide 1/2-inch thick, coated, fibrous-glass duct casing lining complying with ASTM C1071. Secure with adhesive.
 - Attach a 3/4-inch adhesive of polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25, and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84. Coat any cut edges of fiberglass exposed to the airstream with NFPA 90A approved seal.
 - For the air inlet provide round stub connection for duct attachment. For the air outlet provide s-slip and drive connections. Provide removable panels for access to diverter and other parts requiring service, adjustment, or maintenance; with airtight gasket.

3. Volume Damper

- a. Provide a galvanized steel volume damper with peripheral gasket and self-lubricating bearings.
- b. Perform a Maximum Damper Leakage Test (MDLT) in conformance to AHRI 880 I-P, for 3 percent of nominal airflow at 3-inch wg inlet static pressure when tested in accordance with ASHRAE 130.
- c. Select Damper Position, normally fail-in-state.

4. Electric Heating Coil

- a. Provide a slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:
 - Primary and secondary over-temperature protection
 - Nickel chrome 80/20 heating elements
 - Airflow switch
 - Non-interlocking disconnect switch

5. DDC Controls

Provide bidirectional damper operators and microprocessor-based controller. Provide with room sensor that is compatible with temperature controls specified.

- a. Damper Actuators
 - Provide a 24 V, fail-in-state damper actuator.
- b. Terminal Unit Controller

Provide a pressure independent, variable-air or constant volume controller (as indicated on the drawings) with electronic airflow transducers factory calibrated to minimum and maximum air volumes. Include the following features:

- Proportional, plus integral control of room temperature
- Time-proportional reheat-coil control
- Occupied and unoccupied operating mode
- Remote reset of airflow or temperature set points
- Adjusting and monitoring with portable terminal
- Room Sensor

Provide a wall mounting room sensor, with temperature set-point adjustment and access for connection of portable operator terminal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units level and plumb, and in accordance with NFPA 90A. Maintain sufficient clearance for normal service and maintenance.
 - 1. Identification
 - a. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- B. Connections
 - 1. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems.
 - 2. Install piping adjacent to air terminal units to allow service and maintenance.

3.2 FIELD QUALITY CONTROL

- A. Operational Test
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Remove and replace malfunctioning units and retest.

3.3 SYSTEM STARTUP

- A. Engage a factory-authorized service representative or a commissioning agent to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 2. Verify that controls and control enclosure are accessible.
 - 3. Verify that control connections are complete.
 - 4. Verify that nameplate and identification tag are visible.
 - 5. Verify that controls respond to inputs as specified.

3.4 CLOSEOUT ACTIVITIES

A. Operation and Maintenance

1. Submit 2 copies of the operation and maintenance manuals 30 calendar days prior to testing the following items. Update and re-submit data for final approval no later than 30 calendar days prior to contract completion. Concurrently, submit record drawings providing current factual information, including deviations and amendments to the drawings, and concealed and visible changes in the work.

B. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

-- End of Section 233600 --

SECTION 23 81 00.00 10 - UNITARY AIR CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
 - 1. SD-03 Product Data
 - a. Heat pumps
 - b. Thermostats
 - 2. SD-10 Operation and Maintenance Data
 - a. Heat pumps
 - b. Thermostats

1.2 QUALITY ASSURANCE

- A. Modification of References
 - 1. Accomplish work in accordance with the referenced publications, except as modified by this section. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "the Authority having jurisdiction," "the Administrative Authority," "the Owner," or "the Design Engineer" to mean the Contracting Officer.
- B. Safety
 - 1. Design, manufacture, and installation of unitary air conditioning equipment shall conform to ANSI/ASHRAE 15 & 34.

1.3 REFRIGERANTS

- A. Refrigerants shall have an Ozone Depletion Factor (ODF) of 0.05 or less. The ODF shall be in accordance with the "Montreal Protocol On Substances That Deplete The Ozone Layer," September 1987, sponsored by the United Nations Environment Programme. CFCs and Halons shall not be permitted. Refrigerant shall be an approved alternative refrigerant per EPA's Significant New Alternative Policy (SNAP) listing.

1.4 ENVIRONMENTAL REQUIREMENTS

- A. For proper Indoor Environmental Quality, maintain positive pressure within the building. Ventilation shall meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2. Thermal comfort shall meet or exceed ASHRAE 55.

PART 2 - PRODUCTS

2.1 HEAT PUMPS, AIR TO AIR

- A. CID A-A-50502, except as modified in this article; Type II, Class 1. List units with capacities smaller than 135,000 Btu/hr in the AHRI DCUP; in lieu of listing in the ARI Directory, a letter of certification from ARI that the units have been certified and will be listed in the next Directory will be acceptable. Provide factory assembled units complete with accessories, wiring, piping, and controls. Provide units with air filters as specified in the paragraph entitled "Filters."

- B. Energy Performance
 - 1. Minimum energy efficiency shall be in accordance with ASHRAE 90.1 - IP unless otherwise noted.
- C. Air Coils
 - 1. Extended-surface fin and tube type with seamless copper or aluminum tubes with copper or aluminum fins securely bonded to the tubes. On coils with all-aluminum construction, provide tubes of aluminum alloy 1100, 1200, or 3102; provide fins of aluminum alloy 7072; and provide tube sheets of aluminum alloy 7072 or 5052.
- D. Supplemental Electric Heaters
 - 1. When indicated, provide electrical resistance heaters integral with the unit. Heaters shall have a total capacity as indicated. Provide internal fusing for heaters.
- E. Compressors
 - 1. For compressors above 20 tons, compressor speed shall not exceed 3450 rpm. For equipment over 10 tons, provide automatic capacity reduction of at least 50 percent of rated capacity. Capacity reduction may be accomplished by cylinder unloading, use of multiple, but not more than four compressors, or a combination of the two methods. Units with cylinder unloading shall start with capacity reduction devices in the unloaded position. Units with multiple compressors shall have a means to sequence starting of compressors. Provide compressors with devices to prevent short cycling when shutdown by safety controls.
- F. Mounting Provisions
 - 1. Provide units that permit mounting as indicated. Provide suitable lifting attachment plates to enable equipment to be lifted to normal position.
- G. Temperature Controls

Provide controls as specified in CID A-A-50502 and as modified herein. Provide indoor, electronic, programable thermostats of the adjustable type that conform to applicable requirements of UL 873. Provide programable and manual means for temperature set-back. Provide thermostats capable of controlling supplemental heat as specified in CID A-A-50502. Provide a manual selector switch or other means to permit the supplementary heater to be energized when the heat pump compressor and associated equipment are inoperative. Control supplementary heater with the room thermostat while bypassing the outdoor thermostat. Locate switch adjacent to or as an integral part of the room thermostat. An indicator light on the room thermostat or manual heat switch shall indicate when supplementary heaters are operating. Accomplish automatic switching for system changeover from heating to cooling or cooling to heating and fan operation through the use of a thermostat subbase. Provide system selector switches to provide "AUTO", "COOL", "OFF" and "HEAT" and fan selector switches to provide "AUTOMATIC" and "ON." Provide relays, contactors, and transformers located in a panel or panels for replacement and service. Thermostat shall be BACNET compatible.

- H. Fans
 - 1. Provide belt-driven evaporator fans with adjustable pitch pulleys; except for units less than 5 ton capacity, direct drive with at least two speed taps may be used. Select pulleys at approximately midpoint of the adjustable range.
- I. Casings & Cabinets
 - 1. Heat Pump casings shall be steel, finished with baked enamel with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 - 2. Fan & Coil cabinets shall be enameled steel with removable panels on front and ends with faced, glass-fiber insulation and non-corrosive drain pan with drain pan connection.
- J. Filters

1. Provide filters of the type specified in this section.

K. Filter Boxes

1. Provide when filters are not included integral with air conditioning units or when indicated on the drawings. Construct of not less than No. 20 US gage steel with track, hinged access doors with latches, and gaskets between frame and filters. Arrange filters to filter outside and return air. Provide removable filter assemblies, replaceable without the use of tools.

L. Accessories

1. In addition to accessories specified in CID A-A-50502, provide the following accessories for heat pump units.
 - a. Protective grille around outside unit coils
 - b. Start capacitor kit

2.2 Compact Four-Way Cassette

A. General

1. Indoor, in-ceiling mounted, direct expansion four-way cassette indoor units are matched with a heat pump variable refrigerant flow (VRF) outdoor unit. Unit shall be Engineering Testing Laboratory (ETL) listed and certified to UL 1995 4th edition standard.
2. Indoor, direct expansion, low profile (10.6 inches), compact (22.6 x 22.6) in-ceiling fan coil. Unit shall be complete with a coil, fan drive by DC inverter motor, pulse modulating valve (PMV), piping connectors, electrical controls, microprocessor control system, integral temperature sensing, condensate pump with a lift capability of 24.7 inches, and hanging brackets.

B. Unit Cabinet

1. Cabinet shall be constructed of zinc-coated steel. Fully insulated discharge and inlet grilles shall be high-impact non-metallic material. The inlet grille shall have hinges and can be opened to obtain access to the cleanable filters, indoor fan motor and control box.

C. Fans

1. Fan shall be centrifugal direct-drive blower type with air intake in the center of the unit and discharge at the perimeter. Automatic, motor-driven vertical air sweep shall be provided standard. Automatic moto-driven louvers shall be provided standard and shall be adjustable for 2, 3 or 4-way discharge. Air sweep operation shall provide three user selectable modes.

D. Coil

1. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wettability. A drip pan under the coil shall have a factory-installed condensate pump and drain connection for hose attachment to remove condensate. A replaceable element in the condensate disposal system provides antibacterial protection.

E. Motors

1. Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be inverter controlled variable speed.

F. Controls

1. The system shall be microprocessor controlled to maintain precise room temperature and

minimum power consumption. The controls system shall employ a genetic algorithm for temperature control.

2. Wired Remote Controller

- a. Wired remote control shall communicate over two-core shielded wire up to 1640 feet. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air can be sensed at the remote controller. The local control shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.

G. Functions

The unit shall be enabled with the following functions as a minimum:

1. Selectable automatic restart. After power failure the system will restart at the same operating conditions as before the failure.
2. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control.
3. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
4. Automatic air sweep control to provide multiple operating modes of the air sweep louvers.
5. Dehumidification mode shall provide increased latent removal through total system modulation.
6. Fan-only operation to provide room air circulation when no cooling is required.
7. Fan speed control shall be user-selectable: high, medium, low, or microprocessor determined (Auto) based on the differential between the room temperature and the set point during all modes of operation.
8. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
9. Cold blow prevention in heating.
10. Adjustable compensation for air stratification in heating.

H. Filters

1. Unit shall have factory supplied resin net (cleanable) type filters. The return air filter material shall have the following characteristics.
 - a. Odorless
 - b. Temperature resistant to 185 degrees Fahrenheit
 - c. Humidity resistant up to 95% RH

I. Electrical Requirements

1. Indoor units shall be provided with power to support 208/230-1-60 (V-Ph-Hz) in accordance with NFPA 70 NEC.

J. Special Features

1. Compact four-way cassette shall be provided with manufacturer's model compatible ceiling panel (grille).

2.3 FILTERS

1. Provide filters to filter outside air and return air and locate inside air conditioners or inside filter box. Provide replaceable (throw-away) type. Filters shall conform to UL 900. Polyurethane filters shall not be used.

B. Replaceable Type Filters

1. ASTM F 1040 throw-away frames and media, standard dust holding capacity, 350 fpm maximum face velocity, and 2 inches thick. Filters shall have a minimum efficiency reporting value (MERV) of 8 when tested in accordance with ASHRAE 52.2.

2.4 MOTORS AND STARTERS

- A. NEMA MG 1, NEMA ICS 1, and NEMA ICS 2. Variable speed. Motors less than hp shall meet NEMA High Efficiency requirements. Motors 1 hp and larger shall meet NEMA Premium Efficiency requirements. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Provide motors to operate at full capacity with a voltage variation of plus or minus 10 percent of the motor voltage rating. Motor size shall be sufficient for the duty to be performed and shall not exceed its full load nameplate current rating when driven equipment is operated at specified capacity under the most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, the Contractor shall make the necessary adjustments to the wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided.

2.5 REFRIGERANT PIPING AND ACCESSORIES

- A. Provide accessories as specified in FS OO-A-374, CID A-A-50502 and this section. Provide suction line accumulators as recommended by equipment manufacturer's installation instructions. Refrigerant piping and accessories shall be as specified in Section 23 23 00 Refrigerant Piping.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Install equipment and components in a manner to ensure proper and sequential operation of equipment and equipment controls. Install equipment not covered in this section, or in manufacturer's instructions, as recommended by manufacturer's representative. Provide proper foundations for mounting of equipment, accessories, appurtenances, piping and controls including, but not limited to, supports, vibration isolators, stands, guides, anchors, clamps and brackets. Foundations for equipment shall conform to equipment manufacturer's recommendation, unless otherwise indicated. Set anchor bolts and sleeves using templates. Provide anchor bolts of adequate length. Level equipment bases, using jacks or steel wedges, and neatly grout-in with a nonshrinking type of grouting mortar. Locate equipment to allow working space for servicing including shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines. Provide electric isolation between dissimilar metals for the purpose of minimizing galvanic corrosion.
- B. Unitary Air Conditioning System
 1. Install as indicated, in accordance with requirements of ANSI/ASHRAE 15 & 34, and the manufacturer's installation and operational instructions.

3.2 AUXILIARY DRAIN PANS, DRAIN CONNECTIONS, AND DRAIN LINES

- A. Provide auxiliary drain pans under units located above finished ceilings or over mechanical or electrical equipment where condensate overflow will cause damage to ceilings, piping, and equipment below. Provide separate drain lines for the unit drain and auxiliary drain pans. Trap drain pans from the lowest point or bottom to ensure complete pan drainage. Provide drain lines full

size of drain opening. Traps and piping to drainage disposal points shall conform to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.3 ACCESS PANELS

- A. Provide access panels for concealed valves, controls, dampers, and other fittings requiring inspection and maintenance.

3.4 AIR FILTERS

- A. Allow access space for servicing filters. Install filters with suitable sealing to prevent bypassing of air.

3.5 FLASHING AND PITCH POCKETS

- A. Provide flashing and pitch pockets for equipment supports and roof penetrations and flashing where piping or ductwork passes through exterior walls.

3.6 FIELD QUALITY CONTROL

A. Leak Testing

1. Upon completion of installation of air conditioning equipment, test factory- and field-installed refrigerant piping with an electronic-type leak detector. Use same type of refrigerant to be provided in the system for leak testing. When nitrogen is used to boost system pressure for testing, ensure that it is eliminated from the system before charging. Minimum refrigerant leak field test pressure shall be as specified in ANSI/ASHRAE 15 & 34, except that test pressure shall not exceed 150 psig on hermetic compressors unless otherwise specified as a low side test pressure on the equipment nameplate. If leaks are detected at time of installation or during warranty period, remove the entire refrigerant charge from the system, correct leaks, and retest system.

B. Evacuation, Dehydration, and Charging

1. After field charged refrigerant system is found to be without leaks or after leaks have been repaired on field-charged and factory-charged systems, evacuate the system using a reliable gage and a vacuum pump capable of pulling a vacuum of at least one mm Hg absolute. Evacuate system in accordance with the triple-evacuation and blotter method or in accordance with equipment manufacturer's printed instructions and recharge system.

C. Start-Up and Initial Operational Tests

1. Test the air conditioning systems and systems components for proper operation. Adjust safety and automatic control instruments as necessary to ensure proper operation and sequence.

D. Performance Tests

1. Upon completion of evacuation, charging, startup, final leak testing, and proper adjustment of controls, test the systems to demonstrate compliance with performance and capacity requirements. Test systems for not less than 8 hours, record readings hourly. At the end of the test period, average the readings, and the average shall be considered to be the system performance.

-- End of Section 23 81 00.0010 --

SECTION 23 82 02.00 10 - UNITARY HEATING AND COOLING EQUIPMENT

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Provide electrical equipment, motors, motor efficiencies, and wiring. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above shall be the premium efficiency type in accordance with NEMA MG 1. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings with grease supply fittings shall have grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

1.2 SUBMITTALS

Submit the following:

- A. SD-03 Product Data
1. Dedicated Outdoor Air System
 2. Variable Refrigerant Flow Outdoor Units
- B. SD-06 Test Reports
1. System Performance Tests
- C. SD-10 Operation and Maintenance Data
1. Dedicated Outdoor Air System Manuals
 2. Variable Refrigerant Flow Outdoor Units
 3. Manuals
- D. SD-11 Closeout Submittals
1. Dedicated Outdoor Air System Warranty
 2. Variable Refrigerant Flow Outdoor Units
 3. Warranty

1.3 QUALITY ASSURANCE

- A. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Standard Products

1. Provide Materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design, and workmanship.
2. Data shall include manufacturer's recommended installation instructions and procedures, including Operation and Maintenance Manuals. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.
3. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.
4. Where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted.
5. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above shall be included. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.
6. Products shall be supported by a service organization. Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract. System components shall be environmentally suitable for the indicated locations.

B. Nameplates

1. Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Nameplates shall be durable and legible throughout equipment life and shall be fixed in prominent locations with nonferrous screws or bolts.

C. Safety Devices

1. Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

2.2 DEDICATED OUTDOOR AIR SYSTEM

- A. Unit shall be variable air volume (VAV), air-cooled factory assembled, weatherproof packaged unit as

indicated. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ANSI/AHRI 210/240 or ANSI/AHRI 340/360. Unit shall be provided with equipment as specified in paragraph "Equipment Components". Evaporator or supply fans shall be single-width, single inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Motors shall have open drip proof or totally enclosed enclosures. Unit shall have an integral air-flow measuring system (AFMS) on the outdoor air intake. Condenser fans shall be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged with refrigerant and oil in accordance with manufacturer's recommendations.

B. Air-to-Refrigerant Coils

1. Air-to-refrigerant coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

C. Compressor

1. Compressor shall be scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors shall be provided with capacity reduction devices to produce automatic capacity reduction of down to 20 percent either by variable loading compressors or hot gas reheat. When two or more compressors are used, each compressor shall have an independent refrigeration circuit through the condenser and evaporator.
2. Compressors shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, high and low-pressure safety cutoffs, low ambient start kits and protection against short cycling.

D. Refrigeration Circuit

1. Refrigerant containing components shall comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control.

E. Unit Controls

1. Unit shall be internally prewired with a circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure and safety interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature of 105 degrees Fahrenheit. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995.

F. Cabinet Construction

1. Cabinet shall be totally enclosed. Enclosure surfaces shall be pulsation free, with hinged and removable doors and panels for vertical side or front access to unit components. Routine maintenance access to compressor and system control components shall be possible without unit shut-down. Enclosure surfaces shall be thermally and acoustically insulated. Interior baffle and compartment surfaces shall be galvanized steel. Drain pans shall collect all condensate and be steel with external insulation as required. Surface mounting steel pads and vibration isolating pads shall be provided. Enclosure surfaces shall be prepared, primed and powder coat painted.

2.3 Variable Refrigerant Flow Outdoor Units

- A. The heat pump variable refrigerant flow system is a two-pipe system consisting of a single outdoor unit, multiple indoor units, individual unit controls with on/off temperature settings, all connected by fully insulated refrigerant lines utilizing factory supplied, fully insulated, branching kits. Indoor units are connected to condensate piping that shall be terminated to nearest drain point as indicated in plans.
- B. Units shall be listed by Engineering Testing Laboratory (ETL) and be evaluated in accordance with UL standard 1995, 4th Edition. Unit shall be listed in the ASHRI directory. All units shall meet the Federal minimum efficiency standards and be tested per AHRI 210/240 Standard.
- C. General
 1. Factory-assembled, single piece air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the single invert-driven twin rotary compressor. The maximum sound pressure rating shall not exceed 55 dBA in cooling and 58 dBA in heating. Sound pressure ratings are measured at a distance of 3.3 feet out and 4.9 feet up from the front of the outdoor unit (fan discharge side). The outdoor unit shall include an oversized accumulator and a liquid tank for proper heating performance while allowing the indoor unit pulse modulating valve (PMV) metering device to shut off completely when a zone is satisfied. The outdoor unit shall be protected by a high-pressure switch, high-pressure sensor, low-pressure sensor, fusible plugs, PC board, and inverter overload protector. The outdoor unit shall be capable of operating in cooling mode down to 23 degrees Fahrenheit dry bulb ambient air temperature, and down to -13 degrees Fahrenheit wet bulb ambient air temperature in heating.
- D. Unit Cabinet
 1. Unit cabinet shall be constructed of pre-coated steel, finished on both inside and outside. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fans, and control components. Compressor shall be isolated in a compartment and have an acoustic wrap to assure quiet operation. The outdoor unit control panel shall include a sliding window to access adjustable controls and an LED display for setup and diagnostics.
- E. Fans
 1. Outdoor fans shall discharge air horizontally and be driven by a DC inverter variable speed motor with 32 steps. Outdoor fan motor shall be totally enclosed with permanently-lubricated bearings. Motor shall be protected by internal thermal overload protection. Fan blade shall be non-metallic and shall be statically and dynamically balanced. Outdoor fans shall be protected by a metallic protective grille.
- F. Compressors
 1. Outdoor unit shall be equipped with a single inverter-driven twin rotary compressor with full range control to an accuracy of ± 0.1 Hz. Compressor shall be totally enclosed in the machine compartment. Internal overloads shall protect the compressor from over-temperature operation. Motor shall be suitable for operating in an R-410A refrigerant atmosphere. Compressor assembly shall be installed on rubber vibration isolators according to the manufacturer's recommendations.
- G. Outdoor Coil
 1. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed. The coil configuration shall be two-sided. The coil fins shall have a factory-applied corrosion resistant blue-fin finish.
- H. Controls and Safeties
 1. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following.
 - a. Controls:
 - Compressor speed to match the refrigerant flow and capacity with the system requirements.

- Outdoor fan motor speed for higher efficiency and lower sound.
- Oil control for improved system reliability and comfort.
- Pulse modulating valve control for precise control of the refrigerant distribution and accurate capacity management to avoid starving any units.

b. Safeties:

- High-Pressure Switch
- Fuses
- Fusible plug
- Overcurrent relay for the compressor
- Thermal protectors for compressor and fan motor
- Compressor time delay
- Overcurrent sensor
- Compressor suction and discharge temperature sensor
- Compressor suction and discharge pressure sensor

I. Electrical Requirements

1. All sizes shall utilize 208/230-1-60 field power supply. Two-core, stranded, shielded low voltage cable shall be required for communication between outdoor and indoor units. All power and control wiring shall be installed per NEC and all local electrical codes.

J. Refrigerant Piping and Line Lengths

1. Piping connections shall be from the front or the bottom of the unit. The unit shall be capable of operating with maximum connected refrigerant line lengths up to 591 feet actual based on total system capacity and refrigerant amount. The outdoor unit shall have the ability to operate with a maximum height the 164 feet between the outdoor unit and the lowest indoor unit. The maximum distance between the outdoor unit and the furthest fan coil shall not exceed 328 feet actual or 410 feet equivalent. No line size changes or oil traps shall be required. The system shall be capable of operating when the height difference between the upper and lower fan coil is 49 feet.

K. Auxiliary Refrigerant Components

1. All field-supplied copper tubing connecting the outdoor unit to the indoor unit shall use factory-supplied branching kits consisting of either Y joints or headers to ensure even refrigerant flow. To ensure piping flexibility, the system shall allow having Y joints or headers downstream of another header.

2.4 EQUIPMENT EFFICIENCY

1. Unit shall have an efficiency as indicated on the drawings.

2.5 EQUIPMENT COMPONENTS

A. Refrigerant and Oil

1. Refrigerant shall be 410a. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

B. Filter/Drier

1. Furnish and install with high capacity filter/drier protects the system from dirt and moisture.

C. Freezestat

1. Furnish and install with a freezestat that protects the evaporator coil from damaging ice build-up due to conditions such as low/no air flow, or low refrigerant charge.

D. Fans

1. Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction

block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a open drip proof enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves to provide not less than 20 percent fan-speed adjustment. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans shall be direct-drive type with fixed pitch blades. V-belt driven fans shall be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and adjustable pitch sheaves.

E. Air Filters

- a. Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586.

1. Extended Surface Pleated Panel Filters

- a. Filters shall be 2 inch depth sectional type and shall have an average efficiency of MERV 8 (unless otherwise indicated) when tested in accordance with ASHRAE 52.2. Initial resistance at 500 feet/minute will not exceed 0.1 inches water gauge. Filters shall be UL Class 2. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

F. Coil Frost Protection

1. Each circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

G. Internal Dampers

1. Dampers shall be parallel blade type with renewable blade seals and be integral to the unit. Damper provisions shall be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers shall have minimum position stops, have automatic modulation and operate as specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

- A. Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.
- B. Equipment

1. Refrigeration equipment and the installation thereof shall conform to ANSI/ASHRAE 15 & 34. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing pads shall be provided.

3.3 CLEANING AND ADJUSTING

- A. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 DEMONSTRATIONS

- A. Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 2 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.
- B. Submit a schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.
- C. Submit the field posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.
- D. The posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.
- E. Submit 2 complete copies of maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

- A. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.
- B. Refrigerant Leakage
 1. If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.
- C. Contractor's Responsibility
 1. Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if

the leak is the result of defective equipment, material, or installation.

3.6 SYSTEM PERFORMANCE TESTS

1. Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed.

-- End of Section 23 82 02.00 10--

SECTION 23 82 46.00 40 - ELECTRIC UNIT HEATERS

PART 1 - GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. All publications shall be the latest revision in effect on the date of solicitation except where a date is given. The contractor shall comply with all Federal, State, and local regulations.

UNDERWRITERS LABORATORIES (UL)

UL1996

(2009; Reprint Aug 2022) UL
Standard for Safety Electric Duct
Heaters

1.2 SUBMITTALS

- A. Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-03 Product Data
 - a. Performance Data;
 - b. Electric Unit Heaters: to include performance data and controls
2. SD-10 Operation and Maintenance Data
 - a. Electric Unit Heaters;
3. SD-11 Closeout Submittals
 - a. Electric Unit Heaters Warranty

PART 2 - PRODUCTS

1.3 SYSTEM DESCRIPTION

- A. Provide suspended electric unit heaters, and arrange for the discharge of air as indicated.
- B. Provide electric unit heaters with at least the indicated capacity and ensure that they conform to the requirements specified herein. Ensure that the electric unit heaters are factory-prewired and ready for field terminal connections. Ensure products conform to the requirements of UL 1996 for electric unit heaters.
- C. Submit performance data for electric heaters, including use life, test, system functional flows, safety features, and mechanical automated details.

1.4 COMPONENTS

- A. Heating Element
1. Provide a heating element constructed of a resistance wire insulated by highly compacted refractory insulation protected by a sealed metallic-finned sheath. Provide component materials as follows:
 - a. Provide a resistance wire of not less than 20-helix wound alloy of approximately 80-percent nickel and 20-percent chromium.

- b. Provide a refractory insulation of magnesium oxide with a resistance of not less than 50,000 ohms after exposure to an ambient temperature and humidity of 90 degrees F and 85 plus or minus 5-percent relative humidity, respectively, for not less than 24 hours.
 - c. Provide a sheathing consisting of aluminum fins cast around an internal steel sheath containing refractory insulation and resistance wire or carbon-steel fins permanently attached to a tubular carbon-steel sheath containing refractory insulation and resistance wire and with external surfaces porcelainized.
 2. Ensure that the maximum surface temperature of cast-aluminum sheathing is 500 degrees F.
- B. Controls
 1. Provide wall-mounted thermostats complete with thermometer, mechanical high-limit stop, calibrated operator, and an adjustable heater to prevent override of space temperature with a range between 55 and 105 degrees F and a differential not exceeding 1.5 degrees F. Provide a thermostat rated for operation at 24 volts, 60 hertz. Provide transformers, wiring, and devices necessary to meet this requirement. Provide a casing finish in semi-gloss powder coated baked enamel.
- C. Propellers and Motors
 1. Provide propellers with galvanized-steel blades statically and dynamically balanced to within 0.5 percent. Provide units with fan-inlet safety guards.
 2. Ensure that propellers and motors are AMCA-certified for air performance and noise level.
 3. Protect motors against damage by the heating element and resilient mount. Ensure that propellers and motors conform to Section 26 60 13.00 40
 4. LOW-VOLTAGE MOTORS for motors, except that load-matched and custom-designed motors may be used and be so identified on the shop drawings. For motors not so identified, conform to the requirements specified.
 5. Sub fractional and fractional custom-designed or applied motors may deviate from the preceding motor requirements as follows:
 - a. Shaded-pole motors rated less than 1/6 horsepower may be used for direct-drive service.
 - b. Permanent split-capacitor, split-phase, and capacitor-start motors rated 1/4 horsepower or less may be used for direct-drive service.
 - c. Split-phase and capacitor-start motors, rated 1/4 horsepower or less, may be used for belt-drive service.
 - d. Motor bearings may be the manufacturer's standard prelubricated sleeve type but provide the motor with antifriction thrust bearings, when specified. Ensure that the lubricant provisions are for extended service, requiring replenishment not more than twice per year of continuous operation.
 6. Provide the manufacturer's standard motor identification plate.
 7. Provide the manufacturer's standard motor speed and control.

PART 3 - EXECUTION

1.5 INSTALLATION

- A. Install unit heaters in accordance with the manufacturer's instructions at the mounting heights indicated.
- B. Casings
 1. Provide casings with smoothly contoured propeller orifice rings of at least 20-gage cold-rolled carbon steel. Provide a casing surface finish with phosphate pretreatment, prime coating, and

baked-enamel finish.

C. Air Distribution

1. Provide horizontal units with adjustable single- or double-deflection louvers.

1.6 FIELD QUALITY CONTROL

- A. Demonstrate in the presence of the Contracting Officer that the unit heaters operate satisfactorily.
- B. Cycle unit heaters five times, from start to operating thermal conditions to off, to verify adequacy of construction, system controls, and component performance.
- C. Conduct an operational test for a minimum of 6 hours.

-- End of Section 23 82 46.00 40 --

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Alpha Wire Company.](#)
 - 2. [American Insulated Wire Corp.](#)
 - 3. [Belden Inc.](#)
 - 4. [Cerro Wire LLC.](#)
 - 5. [Encore Wire Corporation.](#)
 - 6. [General Cable Technologies Corporation.](#)
 - 7. [General Cable; General Cable Corporation.](#)
 - 8. [Senator Wire & Cable Company.](#)
 - 9. [Southwire Company.](#)
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.
- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.
- E. VFC Cable:
 - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 - 2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [3M.](#)
 2. [AFC Cable Systems, Inc.](#)
 3. [Gardner Bender.](#)
 4. [Hubbell Power Systems, Inc.](#)
 5. [Ideal Industries, Inc.](#)
 6. [ILSCO.](#)
 7. [NSi Industries LLC.](#)
 8. [O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.](#)
 9. [Tyco Electronics Corp.](#)
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- B. Exposed Feeders: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade and Underground: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade and Underground: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.
- H. Branch Circuits Installed below Raised Flooring: Type THHN for dry and damp locations; THWN-2 for wet locations. Single conductors in raceway.

- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- J. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections for feeder and select branch circuit megger testing.
- B. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
- C. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.

2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment, plus the following special applications:
 1. Underground distribution grounding.
 2. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 1. Ground rods.
 2. Grounding arrangements and connections for separately derived systems.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 1. Include the following:
 - a. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Burndy: Part of Hubbell Electrical Systems.](#)
 2. [ERICO International Corporation.](#)
 3. [Galvan Industries, Inc.; Electrical Products Division, LLC.](#)
 4. [Harger Lightning & Grounding.](#)
 5. [ILSCO.](#)
 6. [O-Z/Gedney; a brand of Emerson Industrial Automation.](#)
 7. [Robbins Lightning, Inc.](#)

8. [Siemens Power Transmission & Distribution, Inc.](#)
9. [Thomas & Betts Corporation, A Member of the ABB Group.](#)

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards/panelboards, up to 600 V shall be Lexan or PVC, impulse tested at 5000 V.
- D. Grounding Bus: For specialty areas, 3 inch x 1/4 inch.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 1. Bury at least 24 inches below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Welded connectors.
- 3.2 GROUNDING AT THE SERVICE
- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.
- 3.3 GROUNDING SEPARATELY DERIVED SYSTEMS
- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.
- 3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS
- A. Comply with IEEE C2 grounding requirements.
- 3.5 EQUIPMENT GROUNDING
- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

- G. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of

foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.7 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by calibrated ground test meter.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Requirements:
 - 1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - c. Nonmetallic support systems.
 - d. Trapeze hangers.
 - e. Clamps.
 - f. Turnbuckles.
 - g. Sockets.
 - h. Eye nuts.
 - i. Saddles.
 - j. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: Designed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
 - 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Nonmetallic slotted-channel systems.
 - 4. Equipment supports.
 - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
 - 1. Include design calculations and details of trapeze hangers.
 - 2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which hangers and supports will be attached.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Items penetrating finished ceiling, including the following:

- a. Lighting fixtures.
- b. Air outlets and inlets.
- c. Speakers.
- d. Sprinklers.
- e. Access panels.

B. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; a part of Atkore International.](#)
 - b. [B-line, an Eaton business.](#)
 - c. [ERICO International Corporation.](#)
 - d. [Flex-Strut Inc.](#)
 - e. [GS Metals Corp.](#)
 - f. [G-Strut.](#)
 - g. [Haydon Corporation.](#)
 - h. [Metal Ties Innovation.](#)
 - i. [Thomas & Betts Corporation, A Member of the ABB Group.](#)
 - j. [Unistrut; Part of Atkore International.](#)
 - k. [Wesanco, Inc.](#)
 2. Material: Galvanized steel.
 3. Channel Width: 1-5/8 inches.
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: Stainless-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMTs, IMCs, RMCs, EMTs, IMCs, and RMCs may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Metal conduits, tubing, and fittings.
 2. Nonmetal conduits, tubing, and fittings.
 3. Metal wireways and auxiliary gutters.
 4. Boxes, enclosures, and cabinets.
 5. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
 1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
 2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

- A. IMC: Intermediate Metal conduit.
- B. RMC: Rigid Metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [AFC Cable Systems; a part of Atkore International.](#)
 2. [Allied Tube & Conduit; a part of Atkore International.](#)
 3. [Anamet Electrical, Inc.](#)
 4. [Calconduit.](#)
 5. [Electri-Flex Company.](#)
 6. [FSR Inc.](#)
 7. [Opti-Com Manufacturing Network, Inc \(OMNI\).](#)

8. [O-Z/Gedney; a brand of Emerson Industrial Automation.](#)
 9. [Picoma Industries, Inc.](#)
 10. [Republic Conduit.](#)
 11. [Robroy Industries.](#)
 12. [Southwire Company.](#)
 13. [Thomas & Betts Corporation, A Member of the ABB Group.](#)
 14. [Topaz Lighting Corp.](#)
 15. [Western Tube and Conduit Corporation.](#)
 16. [Wheatland Tube Company.](#)
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. EMT, RMC, IMC: Comply with ANSI C80.3 and UL 797.
- D. FMC: Comply with UL 1; zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [AFC Cable Systems; a part of Atkore International.](#)
 2. [Anamet Electrical, Inc.](#)
 3. [Arco Corporation.](#)
 4. [CANTEX INC.](#)
 5. [CertainTeed Corporation.](#)
 6. [Condux International, Inc.](#)
 7. [Electri-Flex Company.](#)
 8. [Kraloy.](#)
 9. [Lamson & Sessions.](#)
 10. [Niedax Inc.](#)
 11. [RACO; Hubbell.](#)
 12. [Thomas & Betts Corporation, A Member of the ABB Group.](#)
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: Comply with UL 514B.

- G. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [B-line, an Eaton business.](#)
 2. [Hoffman; a brand of Pentair Equipment Protection.](#)
 3. [MonoSystems, Inc.](#)
 4. [Square D.](#)
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Adalet.](#)
 2. [Crouse-Hinds, an Eaton business.](#)
 3. [EGS/Appleton Electric.](#)
 4. [Erickson Electrical Equipment Company.](#)
 5. [FSR Inc.](#)
 6. [Hoffman; a brand of Pentair Equipment Protection.](#)
 7. [Hubbell Incorporated.](#)
 8. [Kraloy.](#)
 9. [Milbank Manufacturing Co.](#)
 10. [MonoSystems, Inc.](#)
 11. [Oldcastle Enclosure Solutions.](#)
 12. [O-Z/Gedney; a brand of Emerson Industrial Automation.](#)
 13. [RACO; Hubbell.](#)
 14. [Robroy Industries.](#)
 15. [Spring City Electrical Manufacturing Company.](#)
 16. [Stahlin Non-Metallic Enclosures.](#)
 17. [Thomas & Betts Corporation, A Member of the ABB Group.](#)
 18. [Wiremold / Legrand.](#)
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Metal Floor Boxes:
 1. Material: Sheet metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 5. Provide type indicated on the drawings.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
 - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Armorcast Products Company](#).
 - b. [Carson Industries LLC](#).
 - c. [NewBasis](#).
 - d. [Oldcastle Precast, Inc.](#)
 - e. [Quazite: Hubbell Power Systems, Inc.](#)
 - f. [Synertech Moulded Products](#).
 - 2. Standard: Comply with SCTE 77.
 - 3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Cover Legend: Molded lettering, "ELECTRIC."
 - 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: IMC, RMC.
 - 2. Concealed Conduit, Aboveground: IMC, RMC.
 - 3. Underground Conduit: PVC, Type EPC-40-PVC, concrete encased below building and under roadways.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed and Subject to Severe Physical Damage: IMC, RMC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Damp or Wet Locations: IMC, RMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
 - 7. 400 Hz Circuits: Aluminum rigid conduit.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Metal Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install

horizontal raceway runs above water and steam piping.

- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate

having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding and fittings.
- V. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a minimum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- AA. Locate boxes so that cover or plate will not span different building finishes.
- BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- DD. Set metal floor boxes level and flush with finished floor surface.
- EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- FF. All underfloor applications shall utilize FNC.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Tape: Bury warning Tape approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align tape along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.7 PROTECTION

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- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Direct-buried conduit, ducts, and duct accessories.
 - 2. Concrete-encased conduit, ducts, and duct accessories.
 - 3. Handholes and boxes.

1.3 DEFINITIONS

- A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including separators and miscellaneous components.
 - 2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Include accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Include warning tape.
- B. Shop Drawings:
 - 1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole frame support rings.
 - e. Include Ladder details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - h. Include joint details.
 - 2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's written permission.
- B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.2 CONDUIT

- A. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Cantex, Inc.](#)
 - 2. [CertainTeed Corporation.](#)
 - 3. [ElecSys, Inc.](#)
 - 4. [Electri-Flex Company.](#)
 - 5. [Lamson & Sessions](#); Carlon Electrical Products.
- B. Underground Plastic Utilities Duct: PVC Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.
- C. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Elmhurst-Chicago Stone Co.](#)
 - 2. [Oldcastle Precast Group.](#)
 - 3. [Utility Concrete Products, LLC.](#)
 - 4. [Utility Vault Co.](#)
 - 5. [Wausau Tile Inc.](#)
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and

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- tamper-resistant, captive, cover-securing bolts.
- 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 3. Cover Legend: Molded lettering, as indicated for each service.
- 4. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- 5. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

- A. ******* NOT USED ******* Ducts for Electrical Cables More than 600 V: RNC, NEMA Type EPC-40-PVC, in direct buried duct bank where indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- E. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.5 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.

- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes or handholes, to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- F. Building Wall Penetrations: Make a transition from underground duct to IMC or RMC at least 10 feet outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- H. Pulling Cord: Install 100-lbf- test nylon cord in empty ducts.
- I. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 3 inches wider than duct bank on each side.
 - 3. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 - 4. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 5. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than five spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 - 7. Elbows: Use manufactured rigid metal conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 8. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - 10. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 2 inches on each side of duct bank.

11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
 12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
- J. Direct-Buried Duct Banks:
1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
 2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 3. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
 5. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 6. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 7. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum 3 inches of sand as a bed for duct bank. Place sand to a minimum of 6 inches above top level of duct.
- K. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank.

3.6 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
1. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 2. Install handholes with bottom below frost line, 30 inches below grade.
 3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers

- 4. of other handholes 1 inch above finished grade.
Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.
- D. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Advance Products & Systems, Inc.](#)
 - b. [Metraflex Company \(The\)](#).
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a [Presealed Systems](#).

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels, including arc-flash warning labels.
 - 8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

B. ******* NOT USED ******* Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

C. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [Champion America.](#)
 - c. [emedco.](#)
 - d. [Grafoplast Wire Markers.](#)
 - e. [LEM Products Inc.](#)
 - f. [Marking Services, Inc.](#)
 - g. [Panduit Corp.](#)
 - h. [Seton Identification Products.](#)

B. Snap-Around Labels for Raceways and Cables Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceways they identify, and that stay in place by gripping action.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [Marking Services, Inc.](#)
 - c. [Panduit Corp.](#)
 - d. [Seton Identification Products.](#)

C. Self-Adhesive Labels:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [A'n D Cable Products.](#)
 - b. [Brady Corporation.](#)
 - c. [Brother International Corporation.](#)
 - d. [emedco.](#)
 - e. [Grafoplast Wire Markers.](#)
 - f. [Ideal Industries, Inc.](#)
 - g. [LEM Products Inc.](#)
 - h. [Marking Services, Inc.](#)
 - i. [Panduit Corp.](#)
 - j. [Seton Identification Products.](#)
2. Preprinted, 3-mil- thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 - a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the raceway diameter, such that the clear shield overlaps the entire printed legend.
3. Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 - a. Nominal Size: 3.5-by-5-inch.
4. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

5. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 BANDS AND TUBES:

- A. Snap-Around, Color-Coding Bands for Raceways and Cables: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceways or cables they identify, and that stay in place by gripping action.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around cables they identify. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Panduit Corp.

2.5 TAPES AND STENCILS:

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Champion America.
 - c. Ideal Industries, Inc.
 - d. Marking Services, Inc.
 - e. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
- C. Tape and Stencil for Raceways Carrying Circuits 600 V or Less: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. LEM Products Inc.
 - b. Marking Services, Inc.
 - c. Seton Identification Products.
- D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Seton Identification Products.
- E. Underground-Line Warning Tape
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Ideal Industries, Inc.
 - c. LEM Products Inc.
 - d. Marking Services, Inc.
 - e. Reef Industries, Inc.

- f. [Seton Identification Products](#).
2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
 4. Tag: Type I:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Thickness: 4 mils.
 - d. Weight: 18.5 lb/1000 sq. ft..
 - e. Tensile according to ASTM D 882: 30 lbf and 2500 psi.
 5. Tag: Type II:
 - a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Thickness: 12 mils.
 - d. Weight: 36.1 lb/1000 sq. ft..
 - e. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.
 6. Tag: Type ID:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 5 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 28 lb/1000 sq. ft..
 - f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.
 7. Tag: Type IID:
 - a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 8 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 34 lb/1000 sq. ft..
 - f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.
- 2.6 Tags
- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
 1. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:

- a. [Brady Corporation.](#)
 - b. [Carlton Industries, LP.](#)
 - c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
 - e. [Seton Identification Products.](#)
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [Carlton Industries, LP.](#)
 - c. [emedco.](#)
 - d. [Grafoplast Wire Markers.](#)
 - e. [LEM Products Inc.](#)
 - f. [Marking Services, Inc.](#)
 - g. [Panduit Corp.](#)
 - h. [Seton Identification Products.](#)
- C. Write-On Tags:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Carlton Industries, LP.](#)
 - b. [LEM Products Inc.](#)
 - c. [Seton Identification Products.](#)
 2. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to raceway, conductor, or cable.
 3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 4. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 Signs

- A. Baked-Enamel Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal Size: 7 by 10 inches.
 4. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Carlton Industries, LP.](#)
 - b. [Champion America.](#)
 - c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
- B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing and with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal Size: 10 by 14 inches.
 4. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [Champion America.](#)
 - c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
- C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
 2. Thickness:
 - a. For signs up to 20 sq. inches, minimum 1/16-inch.
 - b. For signs larger than 20 sq. inches, 1/8 inch thick.
 - c. Engraved legend with black letters on white face.

- d. Punched or drilled for mechanical fasteners.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.

2.8 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Ideal Industries, Inc.
 - 2. Marking Services, Inc.
 - 3. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
- 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
- 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
- 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.

- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.
- J. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- K. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- L. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.3 IDENTIFICATION SCHEDULE

- A. ******* NOT USED ******* Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply stripes to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. ******* NOT USED ******* Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Snap-around labels. Install labels at 30-foot maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 30-foot maximum intervals.
- D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. ******* NOT USED ******* Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- G. Install instructional sign, including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- J. Conductors To Be Extended in the Future: Attach marker tape to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker-tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- L. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
 1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- M. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.

- O. Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.
 - 1. Comply with NFPA 70E and ANSI Z535.4.

- P. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

- Q. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer,load shedding .

- R. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2- inch-high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

 - 2. Equipment To Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.

- n. Push-button stations.
- o. Power-transfer equipment.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Battery-inverter units.
- s. Battery racks.
- t. Power-generating units.
- u. Monitoring and control equipment.
- v. UPS equipment.

END OF SECTION 260553

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Photoelectric switches.
 - 2. Indoor occupancy and vacancy sensors.
 - 3. Switchbox-mounted occupancy sensors.
- B. Related Requirements:
 - 1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - 2. Interconnection diagrams showing field-installed wiring.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Cooper Industries, Inc.](#)
 2. [Intermatic, Inc.](#)
 3. [Leviton Manufacturing Co., Inc.](#)
 4. [NSi Industries LLC.](#)
 5. [TE Connectivity Ltd.](#)
- B. Description: Solid state, with DPST dry contacts rated for 1000 W incandescent or 1800 VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
 6. Failure Mode: Luminaire stays ON.

2.2 INDOOR OCCUPANCY AND VACANCY SENSORS ***** NOT USED *****

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Cooper Industries, Inc.](#)
 2. [Hubbell Building Automation, Inc.](#)
 3. [Leviton Manufacturing Co., Inc.](#)
 4. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
 5. [Lutron Electronics Co., Inc.](#)
 6. [Philips Lighting Controls.](#)
 7. [Square D.](#)
 8. [Watt Stopper.](#)
- B. General Requirements for Sensors:
1. Ceiling-mounted, solid-state indoor occupancy sensors.
 2. Dual technology.
 3. Integrated power pack.
 4. Hardwired connection to switch ; and BAS and lighting control system.
 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 7. Power: Line voltage
 8. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.

- b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
9. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
10. Bypass Switch: Override the "on" function in case of sensor failure.
11. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
- 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 3000 square feet when mounted 48 inches above finished floor.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS ***** NOT USED *****

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- 1. [Cooper Industries, Inc.](#)
 - 2. [Hubbell Building Automation, Inc.](#)
 - 3. [Leviton Manufacturing Co., Inc.](#)
 - 4. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
 - 5. [Lutron Electronics Co., Inc.](#)
 - 6. [Philips Lighting Controls.](#)
 - 7. [Square D.](#)
 - 8. [Watt Stopper.](#)
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS.
- 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor:
- 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.
 - 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 - 3. Switch Type: SP, dual circuit.
 - 4. Capable of controlling load in three-way application.
 - 5. Voltage: Dual voltage - 120 and 277 V.
 - 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 - 7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 - 8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
 - 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

10. Color: White.
11. Faceplate: Color matched to switch.

2.4 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire- suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 1. Identify controlled circuits in lighting contactors.
 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 2000 kVA.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 – PRODUCTS ***** NOT USED *****

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton Electrical Sector; Eaton Corporation.
 - 2. General Electric Company.
 - 3. Siemens Power Transmission & Distribution, Inc.
 - 4. Square D; by Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated.
 - 1. NEMA 250, Type 2 or Type 3R, as indicated: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers 3 kVA and Smaller: None.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.
- K. Wall Brackets: Manufacturer's standard brackets.
- L. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 30 to 50 kVA: 45 dBA.
2. 51 to 150 kVA: 50 dBA.
3. 151 to 300 kVA: 55 dBA.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
 2. Ratio tests at the rated voltage connections and at all tap connections.
 3. Phase relation and polarity tests at the rated voltage connections.
 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
 6. Applied and induced tensile tests.
 7. Regulation and efficiency at rated load and voltage.
 8. Insulation Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION ***** NOT USED *****

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

- C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 - D. Secure transformer to concrete base according to manufacturer's written instructions.
 - E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
 - F. Remove shipping bolts, blocking, and wedges.
- 3.3 CONNECTIONS
- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
 - D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.
- 3.4 FIELD QUALITY CONTROL
- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
 - B. Remove and replace units that do not pass tests or inspections and retest as specified above.
 - C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.
- 3.5 ADJUSTING
- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
 - B. Output Settings Report: Prepare a written report recording output voltages and tap settings.
- 3.6 CLEANING
- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Include evidence of NRTL listing for SPD as installed in panelboard.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 9. Include wiring diagrams for power, signal, and control wiring.
 - 10. Key interlock scheme drawing and sequence of operations.
 - 11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than fourteen (14) days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without **Owner's** written permission.
 - 3. Comply with NFPA 70E.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 2. Height: 84 inches maximum.
 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 7. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Incoming Mains:
1. Location: Top.
 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

I. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Eaton](#).
2. [Siemens Energy](#).
3. [Square D; by Schneider Electric](#).

- B. Panelboards: NEMA PB 1, distribution type.

- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

- D. Mains: As shown on panel schedule.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Eaton.](#)
2. [Siemens Energy.](#)
3. [Square D; by Schneider Electric.](#)

- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only, as indicated on drawings.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Eaton.](#)
 2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
 3. [Siemens Energy.](#)
 4. [Square D; by Schneider Electric.](#)
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response, if shown on the drawings.
 2. Subfeed Circuit Breakers: Vertically mounted.
 3. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - g. Multipole units enclosed in a single housing with a single handle.
 - h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits. Directory shall utilize final room numbers as determined by Boeing prior to substantial completion.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.8 ELECTRIC SMART METER SPECIFICATIONS

The Advance Meter Reading System (AMRS) Compliant Electric Meter shall meet Department of Defense cybersecurity in addition to the following requirements:

- Current Inputs: Nominal 5A
- Measured Current: 50mA to 10A
- Withstand: 20A Continuous
- Poly Phase (3 voltages and 3 currents)
- Internal storage for recording 2 values or channels for 90 days. It shall be configurable using manufacturer supplied configuration software. Must support interval consumption (15 minute) and demand (15 minute block average)
- It shall allow access to recorded data thru Modbus and Ethernet protocols. Onboard Ethernet communications, base 10/100 with RJ45 connector or pigtail with receptacle connector. Modbus/TCP communication protocol thru external RS485 serial port.
- Front display with ability to display all measured values

The following list of meters were evaluated, meet the AMRS meter specification and shall function within the AMRS platform:

Schneider Electric ION 8650
Schneider Electric ION8600
Schneider Electric PM8000
Electro Industries Nexus 1272
Electro Industries Nexus 1262
Schneider Electric PM5560
Schneider Electric PM800 with PM8ECC network card

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.

- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.
- J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- M. Install filler plates in unused spaces.
- N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 1. Measure loads during period of normal facility operations.
 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Isolated-ground receptacles.
 - 3. Weather-resistant receptacles.
 - 4. Snap switches and wall-box dimmers.
 - 5. Floor service outlets.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc

2. [Hubbell Incorporated; Wiring Device](#)
3. [Leviton Manufacturing Co., Inc.](#)

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.](#)
 - b. [Hubbell Incorporated; Wiring Device-Kellems.](#)
 - c. [Leviton Manufacturing Co., Inc.](#)
- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. **Products:** Subject to compliance with requirements, provide the following:
 - a. [Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc](#)
 - b. [Hubbell Incorporated;](#)
 - c. [Leviton Manufacturing Co., Inc.](#)
 2. **Description:** Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. **Products:** Subject to compliance with requirements, provide the following:
 - a. [Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc](#)
[Hubbell Incorporated;](#)
 - b. [Leviton Manufacturing Co., Inc.](#)

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, the following:
 - a. **Single Pole:**
 - 1) [Cooper](#); AH1221.
 - 2) [Hubbell](#); HBL1221.
 - 3) [Leviton](#); 1221-2.
 - b. **Two Pole:**
 - 1) [Cooper](#); AH1222.

- 2) [Hubbell](#); HBL1222.
- 3) [Leviton](#); 1222-2.

c. [Three Way](#):

- 1) [Cooper](#); AH1223.
- 2) [Hubbell](#); HBL1223.
- 3) [Leviton](#); 1223-2.

d. [Four Way](#):

- 1) [Cooper](#); AH1224.
- 2) [Hubbell](#); HBL1224.
- 3) [Leviton](#); 1224-2.

C. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

D. Telephone Outlet:

1. Description: RJ-45 jacks for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 6. Comply with UL 1863.

2.6 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

2.7 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Minimum two or as indicated on drawings, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.9 FINISHES

A. Device Color:

1. White
2. Isolated-Ground Receptacles: Orange.

- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
 - G. Dimmers:
 - 1. Install dimmers within terms of their listing.
 - 2. Verify that dimmers used for fan speed control are listed for that application.
 - 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
 - H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
 - I. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.
- 3.2 GFCI RECEPTACLES
- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
- 3.3 IDENTIFICATION
- A. Comply with Section 260553 "Identification for Electrical Systems."
 - B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers inside outlet boxes.
- 3.4 FIELD QUALITY CONTROL
- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
 - B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
 - C. Wiring device will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Manufacturer's field service report.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. [Eaton Electrical Sector: Eaton Corporation.](#)
 - 2. [General Electric Company.](#)
 - 3. [Siemens Industry, Inc.](#)
 - 4. [Square D: by Schneider Electric.](#)
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. [Eaton Electrical Sector; Eaton Corporation.](#)
 2. [General Electric Company.](#)
 3. [Siemens Industry, Inc.](#)
 4. [Square D; by Schneider Electric.](#)
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- C. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 or Type 9, as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Install fuses in fusible devices.
- C. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:
 - 1. Section 262413 "Switchboards" for factory-installed SPDs.
 - 2. Section 262416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCESUPPRESSOR

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [ABB USA.](#)
 - 2. [Advanced Protection Technologies Inc. \(APT\).](#)
 - 3. [ALLTEC.](#)
 - 4. [Atlantic Scientific.](#)
 - 5. [Current Technology Inc.](#)
 - 6. [Danaher Power Solutions.](#)
 - 7. [Eaton.](#)
 - 8. [General Electric Company.](#)
 - 9. [Intermatic, Inc.](#)
 - 10. [LEA International.](#)
 - 11. [Leviton Manufacturing Co., Inc.](#)
 - 12. [Liebert; a brand of Emerson Electric Co.](#)
 - 13. [Northern Technologies, Inc.](#)
 - 14. [Raycap, Inc.](#)
 - 15. [Schneider Electric USA, Inc.](#)
 - 16. [Siemens Industry, Inc.](#)
 - 17. [Square D; by Schneider Electric.](#)
 - 18. [Staco Energy Products Co.](#)
 - 19. [Surge Suppression Incorporated.](#)
- B. SPDs: Comply with UL 1449, Type 1.
- C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1
 - 1. SPDs with the following features and accessories:
 - a. Integral disconnect switch.
 - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - c. Indicator light display for protection status.
 - d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - e. Surge counter.
- D. Comply with UL 1283.

- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V, 1200 V for 208Y/120 V.
 - 3. Line to Line: 2000 V for 480Y/277 V, 1000 V for 208Y/120 V.
- G. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 700 V.
 - 2. Line to Ground: 700 V.
 - 3. Line to Line: 1000 V.
- H. SCCR: Equal or exceed 100 kA.
- I. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Square D; by Schneider Electric.](#)
- B. SPDs: Comply with UL 1449, Type 1.
 - 1. Include LED indicator lights for power and protection status.
 - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Comply with UL 1283.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - 3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - 4. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V
- F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 700 V.
 - 2. Line to Ground: 700 V.
 - 3. Neutral to Ground: 700 V.
 - 4. Line to Line: 1200 V.
- G. SCCR: Equal or exceed 100 kA.
- H. Inominal Rating: 20 kA.

2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply

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- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
 - 1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's

written installation requirements.

- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 STAR

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- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of luminaire.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Bulb shape complying with ANSI C79.1.
- F. CRI of minimum 80. CCT of 3500 K and no more than 4100 K
- G. Rated lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 1 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: 277 V ac/120 V ac
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- K. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. powder-coat finish.

2.3 FIXTURES

- A. Comply with fixtures shown on the drawings.

2.4 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

- C. Diffusers and Globes:
 - 1. prismatic acrylic
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Glass: Annealed crystal glass unless otherwise indicated.
 - 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - 5. Housings: Extruded-aluminum housing and heat sink.
 - 6. Powder-coat finish.

- D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.5 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.

- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.

- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.

- G. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
 - 2. Ceiling mount with four-point pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
 - 3. Ceiling mount with hook mount.

- H. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at two point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

- I. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on- site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exit signs.
 - 2. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
 - b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Product Schedule:
 - 1. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment will be attached.

5. Size and location of initial access modules for acoustical tile.
 6. Items penetrating finished ceiling including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Ceiling-mounted projectors.
 - e. Sprinklers.
 - f. Access panels.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Sample Warranty: For manufacturer's warranty.
- 1.6 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
- 1.7 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
- 1.8 QUALITY ASSURANCE
- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.
- 1.10 WARRANTY
- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two year(s) from date of Substantial Completion.

- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
 - 2. Warranty Period for Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. **Manufacturers:** As shown on the drawings.
 - 2. Operating at nominal voltage of 277 V ac.
 - 3. LEED v4 for Healthcare MR Prerequisite "PBT Source Reduction - Mercury" does not allow use of fluorescent lamps. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
 - 4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
 - 5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
 - 6. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.2 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions.
 - 2. Designed to permit relamping without use of tools.
 - 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Housings:
 - 1. Extruded aluminum housing and heat sink.
 - 2. Powder coat finish.
- D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.3 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at two point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
 - 1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
 - 2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect all luminaires. Replace lamps, emergency power units , batteries, signs, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265219

SECTION 265619 – LED EXTERIOR LIGHTING PART

1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
 - 2. Luminaire supports.
 - 3. Luminaire-mounted photoelectric relays.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Wiring diagrams for power, control, and signal wiring.
 - 6. Photoelectric relays.
 - 7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Luminaires.
 2. Structural members to which equipment and luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.
 7. Building features.
 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
 1. Luminaire.
 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- F. Mockups: For exterior luminaires, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.

- E. Lamp base complying with ANSI C81.61.
- F. Bulb shape complying with ANSI C79.1.
- G. CRI of minimum 80. CCT of 3500 K and no more than 4100 K
- H. L70 lamp life of 50,000 hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: 277 V ac / 120 V ac
- L. In-line Fusing: Separate in-line fuse for each luminaire.
- M. Lamp Rating: Lamp marked for outdoor use.
- N. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Atlas Lighting Products.](#)
 - 2. [Cooper Lighting, an Eaton business.](#)
 - 3. [Deco Lighting.](#)
 - 4. [Eaton Corporation.](#)
 - 5. [GE Lighting Solutions.](#)
 - 6. [Intelligent Illuminations, Inc.](#)
 - 7. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
 - 8. [Philips Lighting Company.](#)
 - 9. [Schneider Electric USA, Inc.](#)
 - 10. [Siemens Building Technologies, Inc.](#)
- B. Comply with UL 773 or UL 773A.
- C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.3 LUMINAIRE TYPES

- A. Area and Site: As shown on drawings.
- B. Border: As shown on drawings.
- C. Roadway: As shown on drawings.

2.4 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.

- B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.5 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - a. Color: Dark bronze.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth,

- even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of custom color.
 - c. Color: As selected by Architect from manufacturer's full range.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 1. Sized and rated for luminaire weight.
 2. Able to maintain luminaire position after cleaning and relamping.
 3. Support luminaires without causing deflection of finished surface.
 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
 1. Attached to structural members in walls.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- I. Coordinate layout and installation of luminaires with other construction.

- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
 - K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.
- 3.4 BOLLARD LUMINAIRE INSTALLATION:
- A. Align units for optimum directional alignment of light distribution.
 - 1. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
- 3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES
- A. Aim as indicated on Drawings.
 - B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
- 3.6 CORROSION PREVENTION
- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
 - B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
- 3.7 IDENTIFICATION
- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- 3.8 FIELD QUALITY CONTROL
- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
 - B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
 - C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.

- c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - D. Luminaire will be considered defective if it does not pass tests and inspections.
 - E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- 3.9 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.
- 3.10 ADJUSTING
- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on- site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

SECTION 271000 - BUILDING TELECOMMUNICATIONS CABLING SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. The Telecommunications requirements for this project have been included under the following sections "STATEMENT OF OBJECTIVE (SoO)" at the end of this section. The Contractor shall be responsible for providing all necessary shop drawings showing port locations, diagrams, calculations, materials, equipment as listed in the attached SOO, labor, supervision, testing, transportation, and all other incidentals required for a complete and functional system. All work shall be performed in accordance with UFC 3-580-01 Telecommunications Planning and Design, and TIA-569-C.

1.2 SUBMITTALS

- A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
1. SD-02 Shop Drawings
 - a. Telecommunications drawings
 2. SD-03 Product Data
 - a. Telecommunications cabling (backbone and horizontal)
 - b. Patch panels
 - c. Telecommunications outlet/connector assemblies
 - d. Equipment support frame
- B. Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.
1. SD-06 Test Reports
 - a. Telecommunications cabling testing
 2. SD-07 Certificates
 - a. Telecommunications Contractor Qualifications
 - b. Key Personnel Qualifications
 - c. Manufacturer Qualifications
 - d. Test plan
 3. SD-09 Manufacturer's Field Reports
 - a. Factory reel tests
 4. SD-10 Operation and Maintenance Data
 - a. Telecommunications cabling and pathway system Data Package 5

5. SD-11 Closeout Submittals

a. Record Documentation

1.3 QUALITY ASSURANCE

A. Shop Drawings

1. Telecommunications Drawings

a. Provide registered communications distribution designer (RCDD) approved, drawings in accordance with TIA/EIA-606-A. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA/EIA-606-A. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications and FD's to the telecommunications work area outlets. The following drawings shall be provided as a minimum:

- T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.
- T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.
- T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

B. Telecommunications Qualifications

1. Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

2. Telecommunications Contractor

a. The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

3. Key Personnel

a. Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

b. Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level III.

c. In lieu of BICSI certification, supervisors and 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

and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

C. Test Plan

1. Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the UTP and optical fiber components and accessories 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

D. Standard Products

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.
2. Alternative Qualifications
 - a. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
3. Material and Equipment Manufacturing Date
 - a. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.4 DELIVERY AND STORAGE

- A. Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.6 WARRANTY

- A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 MAINTENANCE

- A. Operation and Maintenance Manuals

1. Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system. Submit operations and maintenance data in accordance with Section 01 78 23.00 44 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, and RECORD DOCUMENTATION.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS CABLING

- A. Cabling shall be UL listed for the application and shall comply with TIA-568-C.1 , TIA/EIA-568-B.2, TIA-568-C.3 and NFPA 70. Provide a labeling system for cabling as required by TIA/EIA-606-A and UL 969. Ship cable on reels or in boxes bearing manufacture date for UTP in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

- B. Backbone Cabling

1. Backbone Copper
2. Backbone Optical Fiber

Provide in accordance with ICEA S-83-596, TIA-568-C.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches

TIA-492AAAA-A, multimode, 62.5/125-um diameter, 0.275 numerical aperture, TIA-492AAAB, multimode, 50/125-um diameter, 0.275 numerical aperture and TIA-492CAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture, tight buffered fiber optic cable nonconductive optical fiber plenum cable (OFNP) in accordance with NFPA 70 and UL 910 The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598-B.

- C. Horizontal Cabling

1. Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568-C.1.
2. Horizontal Copper
 - a. Provide horizontal copper cable in accordance with TIA/EIA-568-B.2, UL 444, NEMA WC 66, ICEA S-90-661 UTP (unshielded twisted pair), 100 ohm. Provide four each individually twisted pair, 24 AWG conductors Category 6, with a blue thermoplastic jacket. Cable shall be imprinted with manufacturer's name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 2 feet. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide communications plenum (CMP) rated cabling in accordance with NFPA 70.
3. Horizontal Optical Fiber
 - a. Provide optical fiber horizontal cable in accordance with ICEA S-83-596, TIA-568-C.3 and TIA-492AAAA-A, multimode, 62.5/125-um diameter, 0.275 numerical aperture, TIA-492AAAB, multimode, 50/125-um diameter, 0.275 numerical aperture TIA-492CAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture, tight buffered fiber optic cables. Cable shall be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 40 inches. Provide nonconductive optical fiber plenum cable (OFNP) in accordance with NFPA 70 The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598-B.

- D. Work Area Cabling

1. Work Area Copper
 - a. Provide work area copper cable in accordance with TIA/EIA-568-B.2
2. Work Area Optical Fiber

- a. Provide optical work area cable in accordance with TIA-568-C.3.

2.2 TELECOMMUNICATIONS SPACES

- A. Provide connecting hardware and termination equipment in the telecommunications entrance facility to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA/EIA-606-A.
- B. Backboards
 1. Provide void-free, interior grade plywood 3/4 inch thick 4 by 8 feet as indicated. Backboards shall be fire rated. Backboards shall be provided on a minimum of two walls in the telecommunication spaces. Do not cover the fire stamp on the backboard

PART 3 EXECUTION

1. Refer to following Section "Statement of Objectives (SOO)" for installation instructions.

END OF SECTION 271000

STATEMENT OF OBJECTIVE (SoO)

For

Inside/Outside Plant Cabling B3321 (East Wing)

6 July 2023 (Updated 22 December 2023)



Prepared by 17 CS/SCXP

328 Ft. Lancaster

Goodfellow AFB TX 76908

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1. SCOPE

This SOW defines the requirement for the Contractor to engineer, furnish, and install a new Telecommunications Room. Contractor will engineer, furnish, install and test (EFI&T) a 24-strand single mode (SM) fiber optic cable (FOC) and 100 Pair Copper Cabling from MH-301 to B3321. Contractor will also EFITT Inside Premise Wiring within Building 3321. The contractor shall EFITT a fully usable CAT 6A Solution for Voice and/or Data usage. (Including but not limited to cabling, wall-plates, wall-boxes, jacks, floor panels, and equipment rack distribution panels) The Contractor shall provide all equipment, tools, materials, supplies, transportation, labor, supervision, management, and other incidentals necessary to meet the requirements as stated in this SOO. All electronics equipment, supplies, and materials to be installed shall be new and not refurbished.

2. REQUIREMENTS

2.1. GENERAL REQUIREMENTS

2.1.1. Safety Requirements

The contractor shall remain in compliance with all Federal, State, and base security and safety laws, regulations, policies, and requirements.

2.1.1.1 Contractor Safety Standard Expectation

The Contractor will comply with all applicable OSHA and Air Force Safety Standards. B431 can potentially have Asbestos in the area being worked therefore the chosen contractor and employees must be Texas State Department of Health Services certified to conduct Asbestos Operations and maintenance (O&M) actions on construction materials that contain asbestos.

2.1.1.2 Base Fire Regulations

The Contractor shall comply with Base Fire Regulations as set forth in the latest edition of GAFB Instruction 32-2001, titled "Base Fire Protection Program". The Contractor shall use no explosives in performing the work. All work shall be in strict compliance with NFPA-101. Contract SOW must reference the USACE Safety and Health Manual EM-385-1-1 and NFPA 241 and must contain the requirement that the Installation's fire regulations be followed. All work shall be in strict compliance with NFPA-101.

2.1.1.2 Base Fire Regulations

The Contractor shall comply with Base Fire Regulations as set forth in the latest edition of GAFB Instruction 32-2001, titled "Base Fire Protection Program". The Contractor shall use no explosives in performing the work. All work shall be in strict compliance with NFPA-101. Contract SOW must reference the USACE Safety and Health Manual EM-385-1-1 and NFPA 241 and must contain the requirement that the Installation's fire regulations be followed. All work shall be in strict compliance with NFPA-101.

2.1.2. Site Coordination

The Contractor shall meet with the base safety officer immediately upon arrival on site for review of the specific safety requirements prior to installation.

2.1.2.1. Confined Space

The Contractors entering spaces on Goodfellow AFB are responsible for the safety of their personnel and for their own confined spaces permit program as outlined in AFI 91-203. All confined space operations must be coordinated with the Base Safety Office prior to start of work.

2.1.2.2. Accident/Incident Reporting and Investigation

The Contractor shall record and report all available facts relating to each instance of injury to the Base Safety Office. The Contractor shall secure the scene of any accident and wreckage until released by the accident investigative authority through the Base POC. If the Government elects to conduct an investigation of the incident, the Contractor shall cooperate fully and assist the Government personnel until the investigation is completed.

2.1.2.3. Work Area(s)

At day's end, the Contractor shall remove all debris and surplus materials from the workplace. Safety barriers shall be in place to protect unfinished work site at the end of the day. All open holes or trenches shall be completely enclosed by flexible orange construction safety fencing, or other safety barriers, at the end of the workday. Equipment and materials required to complete the work effort may remain on site as long as they are organized/stored in a manner that does not cause a safety hazard.

2.1.2.4. Traffic control

In the event base vehicular traffic is to be disrupted by trenching or horizontal directional boring, the Contractor shall make appropriate notifications NLT 10 calendar days in advance to 17 CS/SCXP of the planned disruptions.

2.1.3. Security Requirements

The Contractor shall process and provide a Site Visit Request Letter to 17 CS/SCXP within 5 calendar days after contract award. This spreadsheet shall identify the names (as shown on the driver's license), driver's license numbers and state of issue, and birth date of the personnel who will be performing work under this SOW, company name, address, phone number and contract number, start date and end date. This information is required to grant access to the base. If required by the base, the Contractor shall provide identification badges for their employees. All Contractor personnel shall wear these badges while on duty on the Government site. The badges shall identify the individual, company name, and be clearly and distinctly marked as Contractor and be in accordance with base regulations.

2.1.3.1. Security Clearances

Stated work and associated products shall be performed at the UNCLASSIFIED level. However, some of this work will take place in secure areas where Contractor employees must be escorted at all times. The Contractor must coordinate access to secure areas at least 24 hours ahead of time with the 17 CS/SCXP PM. It is the Government's responsibility to provide escorts.

2.1.3.2. Operational Security (OPSEC)

Network infrastructure (MHDS, MH/HH locations, fiber paths, etc.) is on the 17 CS Critical Information List and must be protected. The Contractor shall take appropriate measures to protect detailed information pertaining to the EFI&T effort, to include appropriate marking of documents as "For Official Use Only (FOUO)," and ensuring limited distribution of documents and schematics/drawings to only those individuals with a valid need to know. In accordance with (IAW) AFI 10-701, OPSEC Considerations, the contractor shall develop an OPSEC plan to ensure the protection of FOUO data either furnished by the government or produced by the contractor. The contractor's OPSEC plan provided in the RFP shall be incorporated into the SOW.

2.1.4. Environmental Compliance

2.1.4.1 Compliance with Laws

Construction activities are NOT exempt from air emission, storm water, hazardous waste, and other environmental compliance rules and regulations. The Contractor shall read Attachment 2: DoD Contractor's Guide, and fully comply and ensure that all Sub-Contractors comply with all applicable Federal, State, and Local laws, regulations, ordinances, and standards related to environmental matters. The Contractor shall also comply and ensure that all Sub-Contractors comply with all specific instructions or directions given to the Contractor by Goodfellow AFB regarding environmental matters.

2.1.4.2 Hazardous and Special Wastes Generated by the Contractor

The Contractor shall identify, characterize, containerize, store, and dispose of hazardous waste in strict accordance with Federal guidelines found in the CFR, Title 40 Volume 26 and 27 parts 260-270, State regulation 30 TAC 335, all local guidelines, and as specified. A Uniform Hazardous Waste Manifest shall be used by the Contractor to document all parties and locations involved in the transportation, storage, and disposal of all hazardous and special waste. This form shall be provided to the Government by the Contractor and signed by the Base Environmental Engineer (17 CES/CEIE) before the waste is transported from the limits of Government property. A copy of the manifest shall be signed by the receiver of the waste and submitted to the Contracting Officer not later than forty-five (45) days after disposal has taken place. Hazardous waste treatment, storage and disposal facility shall be located within the State of Texas, permitted by the U.S. EPA, and approved by CEIE.

2.1.4.3 Contractor Encountered Hazardous Waste

The Contractor shall notify the Contracting Officer and 17 CES/CEIE upon encountering any material not identified in this SOW thought to be hazardous that could jeopardize the safety of workers or personnel in the area. The Government will be responsible for characterization, transportation, storage, and disposal of the waste if necessary.

2.1.4.4 Asbestos

To the best of the Government's knowledge, no asbestos-containing material (ACM) will be encountered during this project. Should the Contractor encounter previously unidentified or suspected ACM which must be disturbed to comply with the contract documents, the Contractor shall cease that work which would disturb the suspect material and shall immediately notify the Contracting Officer. Asbestos Containing Building Materials: Under no circumstances, under the provisions of this contract, shall the Contractor be allowed to provide asbestos containing building materials, or products containing encapsulated asbestos or mineral fibers as defined in the Title 40 Volume 9 Part 61, National Emission Standards for Hazardous Air Pollutants, to Goodfellow AFB. The Contractor shall provide a signed statement, accompanied by Safety Data Sheet (SDS) for project materials, from a licensed asbestos inspector or the project architect or engineer, proclaiming that no asbestos-containing building materials were used in the construction.

2.1.4.5 Hazardous Materials

The Contractor shall provide to the Contracting Officer an AF Form 3000, Material Approval Submittal, listing all materials to be utilized during the contract. If any of the material is classified as hazardous materials in accordance with regulations and AFMAN 32-7002, the Contractor will submit an installation Contractor Hazardous Materials Usage Tracking Form (Attachment 2: DoD Contractor's Guide) for all material items with all supporting information

as required for GA. This is to ensure that all hazardous materials used on the installation are tracked at a level sufficient to ensure contractor compliance with local monitoring, determination, authorization, tracking, and to meet environmental reporting requirements and support fire protection, ESOH, and disaster response efforts. The Contractor must obtain authorization from the Contracting Officer prior to bringing or using any hazardous materials on the installation. The Contractor must supply up to date SDS for each requested items, that were listed as a hazardous material, as defined to be delivered under this contract. The hazardous materials shall be properly identified on the required request form and shall include any applicable identification number (such as part numbers, manufacturers name and any other special item number). This information shall also be included on the SDS submitted under this contract. The Contractor must maintain a file of all SDS. The Contractor shall submit for GA (via AF Form 3000) to the Contracting Officer on a monthly basis, or at the end of the contract, as determined by the Contracting Officer, a Contractor Hazardous Materials Usage Tracking Form (two (2) copies) on the usage of all HAZMAT materials used within that reporting period. No chemicals, lubricants, oils, liquids or related materials shall be deposited in the refuse containers on base.

2.1.4.6 Nuisance and Polluting Activity Prohibited

Polluting, dumping, or discharging of any harmful, nuisance, or regulated materials (such as but not limited to concrete truck washout, vehicle maintenance fluids, residue from saw cutting operations, solid waste and hazardous substances) into building drains, site drains, streams, waterways, holding ponds or to the ground surface shall not be permitted and the Contractor shall be held responsible for any and all damages which may result. Further, the Contractor shall conduct work activities in such a fashion as to avoid creating any legal nuisance, including but not limited to, suppression of noise and dust, control of erosion, and implementation of other measures as necessary to minimize offsite impacts of work activities.

2.1.4.7 Release of Fluids to the Sanitary Sewer System

Goodfellow AFB's sanitary sewer system discharges into the Publicly Owned Treatment Works (POTW) operated by the City of San Angelo, Texas. This POTW has established testing requirements for certain constituents as well as discharge limits of those same constituents. Accordingly, any Contractor performing work at Goodfellow AFB and contemplating a release of non-hazardous water into the sanitary sewer system shall meet the pretreatment standards and comply with the testing/release requirements established by the City of San Angelo. Contractor is also responsible for any and all testing, monitoring, measuring, documenting, etc., to prove compliance. Contractor shall not discharge wastewater to installation's sanitary sewer without prior GA.

2.1.4.8 Air Emissions

The Contractor shall submit air emission reports FIO, monthly and upon completion of the project to the 17 CES/CEIE. See Attachment 2: DoD Contractor's Guide for forms or call 654-3299 for any questions.

2.1.4.9 Construction Management

At the end of the project, and prior to final acceptance, the Contractor shall submit a solid waste diversion report FIO by completing the Construction Waste Management Form identifying the materials and weights either recycled or diverted from solid waste disposal to other re-use as well as weights of waste disposed in a landfill. Please see Attachment 2: DoD Contractor's Guide for forms or call 654-3299 for any questions.

2.1.4.10 ENVIRONMENTAL MANAGEMENT SYSTEM (EMS):

Contractor's on-site supervisory personnel shall complete EMS Awareness Training. The Installation Management Flight system administrator should be contacted at (325) 654-3299 for information and password to complete the thirty (30) minute awareness training within sixty (60) days of contract award or a new contract employee supervisor begins work. The training will be accomplished utilizing a web-based training system called "The Environmental Awareness Course Hub" (TEACH) available through any internet access at <http://usaf.learningbuilder.com>. User will have to register for an account, create a user ID and password, and then take the EMS training. Certificate of completion must then be submitted to the Contracting Officer FIO, and then forwarded to 17 CES/CEIE Environmental Management.

2.1.4.11 Green Purchasing

Green Purchasing is a mandatory component of the Air Force pollution prevention program. The Under Secretary of Defense issued a policy memorandum "Establishment of the DoD Green Purchasing Program (GPP)" which states: "The DoD goal is to achieve 100% compliance with mandatory Federal GPP programs in all acquisition transactions." This document contains guidelines for implementing the Resource Conservation and Recovery Act, (RCRA) EO, DoD, and Air Force requirements.

2.1.4.12 Applicable Environmental Regulations and Laws:

The RCRA, Section 6002 (42 U.S.C. 6962) Title 40, Volume 25, Part 247, Comprehensive Procurement Guideline for Products containing Recovered Material. Energy Policy Act. (EPACT)

2.1.4.13 EPA Recommendations:

The U.S. EPA recommends minimum content levels for those items listed in the attached Construction Products Recovered Materials Form. These levels are mandatory for Air Force procurements unless one (1) of the following exemptions applies:

1. The product is not available from a sufficient number of sources to maintain a satisfactory level of competition (i.e., available from two or more sources.)
2. The product is not available within a reasonable period of time.
3. The product does not meet the performance standards in applicable specifications or fails to meet reasonable performance standards of the procuring agency.
4. The product is not available at a reasonable price. For Air Force purposes, "unreasonable price" is defined as follows: If the price of the recycled-content product exceeds the cost of a non-recycled item, then the price is considered unreasonable.

2.1.4.14 Contractor Responsibility

The Contractor shall complete the attached Construction Products - Recovered Materials Determination Form found in Attachment 2: DoD Contractor's Guide, with respect to the work

and products being provided. Contractor shall provide written documentation when items not meeting the minimum content levels are used. This documentation shall be forwarded to the Contracting Officer via AF Form 3000 for GA. In the event the documentation fails to support the Contractor's findings, the Contracting Officer shall return the documentation to the Contractor citing the reason(s) for disapproval.

2.1.4.15 EPA Designated Items

A complete listing of the U.S. EPA-designated items can be obtained at the following website: <http://www.epa.gov/greenerproducts/recommendations-specifications-standards-andecolabels-federal-purchasing>. Also see: <https://sftool.gov/greenprocurement>. Not all of these materials may be required in the construction of this project. Please refer to the drawings and specifications. The attached Construction Products Recovered Materials Form shall be used to demonstrate compliance with the stated procurement requirements.

Intent: The intent of this section is to increase the use of GPP by all Contractors involved with this project.

The various sections of the specifications contain references to products to be used in the completion of this project. The listed product may or may not be manufactured from or contain recycled materials. Therefore, all Contractors, Sub-Contractors, equipment suppliers, and material suppliers are responsible for compliance with this specification and those items/products listed on the attached form. Recycled products shall be used wherever possible subject to the exemptions as per the paragraph (2.11.2) EXEMPTIONS.

Recycled or Recovered Products: Those materials identified on the form at the end of this section.

Sources of Information: The following is a partial list of sources of information for compliance with GPP requirements:

Select Sources of Supply for Environmentally Preferable Products and Services

- GSA: <http://www.gsa.gov/portal/content/105414>
- DLA: <http://www.dla.mil/WhatDLAOffers/EnvironmentalandSustainablePrograms.aspx>
- Energy Star®: <http://www.energystar.gov/>
- JWOD: http://www.abilityone.gov/procurement_list/product_contractors.html
- UNICOR: http://www.unicor.gov/Shopping/viewCat_m.asp?iStore=UNI&idCategory=1633
- EPA: <https://www.epa.gov/greenerproducts>

Green Procurement Program Product Listings

- CPG: <https://www.epa.gov/greenerproducts>
- Bio based: <http://www.biopreferred.gov/BioPreferred/>
- FEMP: <http://energy.gov/eere/femp/federal-energy-management-program>
- Energy Star: http://www.energystar.gov/index.cfm?fuseaction=find_a_product

- Alternatives to Ozone-Depleting Substances: <https://www.epa.gov/snap>
- For paints, carpet, office supplies, cleaners, and particle board: <http://www.greenseal.org/Home.aspx>
- For construction projects: <https://www.epa.gov/chemicals-under-tsca>

2.1.5. Permits

Base Civil Engineer Work Clearance Request: The Contractor shall receive a completed copy of AF Form IMT 103 from the project manager or contracting officer prior to commencement of work for this project. Due to the requirement for multiple agencies to coordinate digging permit requests, it takes approximately fourteen (14) calendar days for processing of the paperwork. The contractor on site must have a copy of the completed AF Form IMT 103 on them while digging, trenching, or boring.

2.1.6. Integrated Process Team (IPT)

The Contractor shall chair a weekly IPT meeting that includes Contractor representatives, the 38 ES Cyberspace Integrator-Base (CSI-B), the 38 ES System Engineer (SE), the 17 CS/SCXP Project Manager (PM), and other base personnel as required. The Contractor shall provide an agenda and a worldwide “Meet Me” teleconference capability for the duration of the project. The purpose of the IPT meeting is to discuss project progress, problems being encountered, and other information necessary/beneficial to ensure success and timely completion of contract requirements. The Contractor shall record meeting minutes and distribute to the attendees. The contractor shall provide at this meeting a weekly action register, in Microsoft excel, to capture items that need to be addressed. Action register shall have at a minimum Project Description, Contact list, Action Item List, Discrepancy List, and any pertinent information related to the project. (CDRL A004)

2.1.7. Quality Assurance

The Contractor shall provide Quality Assurance Support for the life of the project. The Contractor’s quality assurance evaluator shall assist the Government representative in performing random spot checks and system acceptance tests. The Contractor shall be responsible for identifying system and outside plant deficiencies and /or discrepancies throughout the life of the project. A weekly report (soft copy) shall be submitted indicating progress/status and listing any deficiencies/discrepancies found and actions to correct them. (CDRL A003)

2.1.8. Contractor Personnel

2.1.8.1. Project Management

The Contractor shall provide a Project Manager (PM) and alternate(s) responsible for contract performance and continuity. The Contractor shall identify the Project Manager’s or alternate's range of authority to act for the Contractor relating to daily contract operation.

2.1.8.2. Site Point of Contact (POC)

The Contractor shall designate the Contractor's on-site team leader and alternate(s) as the Site POC for individual projects in their Site Visit Request Letter. The Site POC or alternate(s) shall be on site during duty hours until project completion and shall oversee all facets of the installation tasks. The Site POC shall be the interface for all work site communications with the Government, including quality, safety, and discrepancy matters.

2.1.8.3. Personnel Requirements

The Project Manager, Site POC, and respective alternate(s) shall be able to read, write, speak, and understand English. All reporting and documentation shall be in English.

2.1.9. Electronic Contractor Manpower Reporting Application (ECMRA)

The contractor shall report ALL contractor labor hours (including subcontractor labor hours) required for performance of services provided under this contract for Goodfellow AFB single mode (SM) fiber optic cable (FOC) from ITB to ITB, via a secure data collection site. The contractor is required to completely fill in all required data fields using the following web address <http://www.ecmra.mil>

Reporting inputs will be for the labor executed during the period of performance during each Government fiscal year (FY), which runs October 1 through September 30. While inputs may be reported any time during the FY, all data shall be reported no later than October 31 of each calendar year. Contractors may direct questions to the ECMRA help desk.

2.1.10. Warranty

The Contractor shall provide a one-year warranty or manufacturer's standard commercial warranty, whichever is longer. This warranty shall include a one-year workmanship warranty. The warranty period shall start from the date of system and/or project acceptance. The Contractor shall provide written procedures and required information for warranty services at or prior to site acceptance.

2.2. SPECIFIC REQUIREMENTS

The Contractor shall build a new Telecommunications Room. Contractor shall EFITT SM, indoor/outdoor rated FOC and Copper Cabling from MH-300 to B3321 new Telecomm Room using the existing and new maintenance hole duct bank system. Contractor shall install associated fiber optic distribution panel, with pre-terminated, factory certified connectors within cassette style modules all fusion spliced in Building 3321. The Contractor shall install Non-Shielded CAT 6 cabling for NIPR IT Infrastructure and RG-6 Coaxial Cable. The Contractor shall coordinate with the 17 CS/SCXP Office to transition to the new IT Infrastructure after all testing has been performed. Said transition plan is to be a part of the Contractor's Test Plan.

The Contractor's cabling system solution shall not impede access to electrical boxes/openings or any other existing equipment, such as air dampers, fire alarm devices, or any safety devices, etc.

2.2.1. Maintenance Holes (MHs)

The Contractor shall pump out water as required. Water shall be drained IAW BCE and base environmental requirements.

2.2.2. Measurements

Any distances provided in this SOO are approximations and should NOT be used for ordering materials or determining duct lengths.

2.2.3. Splice Conductors

All fiber splicing shall be performed in accordance with RUS Bulletin 1735F-401, Standards for Splicing Copper and Fiber Cable. The fusion splice method shall be used for all splicing and terminations of fiber optic cable. Fiber optic cables shall be terminated via fusion splice to pigtails with SC connectors.

2.2.4. Cable Racks and Cable Rack Supports

Cable racks shall be installed in maintenance holes as required – this includes new and existing MHs/HHs. Splices shall not be supported by the cables that enter each end of the splice case. The splices shall be supported by cable hooks under the splice case. Telecommunications industry standard cable hooks of the appropriate length shall be provided to support cables and splice cases. The cable hooks shall be secured using cable rack locking clips. All cables shall be supported using racking clips, cable racks, and cable hooks.

2.2.5. Labeling

The Contractor shall label all equipment and cables they install, and cables identified for re-use IAW TIA-606-B-2012 and as directed by the 17CS, SCXP. New ducts shall be permanently labeled on the wall of each building/maintenance hole indicating the connecting building/maintenance hole at the other end of the duct (for example, “To MH-200”). Tagging and labeling of new cables shall be IAW 17CS labeling scheme.

2.2.6. Cable Tags

All tags shall be permanently labeled, easily visible and corrosion resistant. Install cable tags in all maintenance holes/handholes, cable vaults, pull boxes and building entrance terminal locations. When cables pass through a maintenance hole, put a tag on the cable, approximately 2 feet from each duct entrance. Information on the cable tag shall identify cable by size, type, cable number and count. See Para 2.2.5 (above) for nomenclature for tagging.

2.2.7. Pulling Tape

All newly installed ducts left vacant shall be provided with a waterproof, corrosion resistant, pre-lubricated flat woven polyester pull tape with sequential footage markings (1250 lb. pulling strength) for future cable installations. The pull tape shall extend into the maintenance holes and be secured to a cable rack or pulling iron, etc.

2.2.8. Cable Terminations

Fiber optic cables shall be terminated via fusion splice to pigtails with SC connectors in cassette style housing. The pigtails shall be sized the same as the OSP fiber they are spliced to, i.e., 125/8.3 micron to 125/8.3 micron. The pigtails shall be duplex (or simplex) unless otherwise agreed to by 17 CS/SCXP.

2.2.9. OSP Maintenance Loop(s)

The Contractor shall install a minimum of a 50-foot fiber optic cable maintenance loop at the first MH from the building, at every splice point MH location and at every 3rd MH in the route. The maintenance loop slack shall be properly labeled, securely supported to the cable ladder and off the MH floor or in telecomm room.

2.2.10. Grounding/Bonding

Grounding/Bonding hardware such as corrosion resistant wire, bonding ribbon, clamps, ground rod, etc. necessary to properly bond/ground the cable in MHs shall be provided by the Contractor. In addition, grounding/bonding of telecommunication racks to telecomm busbar and building ground if necessary. Reference UFC 3-580-01, TIA 607, and TIA 758.

2.2.11. Underground Conduit System

The Contractor shall be responsible for any required trenching and/or boring necessary to lay the duct system. The Contractor is also responsible for backfilling ditch lines and compaction of fill materials with appropriate compaction tools. Directional drilling shall be used for major road crossings, taxiways, runways, etc. Otherwise, crossing of paved surfaces may be performed by pavement cuts and resurfacing with appropriate matching road material. This does not prevent the Contractor from using directional drilling if it is more cost effective. Ducts will be appropriately protected when placed under paved surfaces (i.e., concrete encasement).

2.2.11.1. Composition. N/A

2.2.11.2. Typical Situations

The ducts shall be 4-inch inside diameter (I.D.) round or metric equivalent. The ducts shall be made of EPC-40 Polyvinyl Chloride (PVC) (Schedule 40) IAW NEMA TC-2. The ducts shall be appropriately labeled indicating the composition material. Ducts shall have a sleeve or bell-end type coupling and shall be watertight when assembled. In addition, the Contractor shall adhere to any additional Host Base/site specific requirements.

2.2.11.3. Unique /Site Specific Situations

The ducts shall be 4-inch inside diameter (I.D.) round or metric equivalent. The ducts shall be made of EPC-80-PVC (Schedule 80) IAW NEMA TC-2; high density polyethylene (HDPE) SIDR 11.5, Galvanized Iron Pipe (GIP) or "thickwall" stainless steel. Schedule 80 PVC shall be limited to risers, all above ground conduit and under the roadway/parking pavement. High density polyethylene (HDPE) SIDR 11.5 shall be used when directional bring is used. GIP or stainless steel shall be used under major roadways, taxiways, and runways. The ducts shall be appropriately labeled indicating the composition material. Ducts shall have a sleeve or bell-end type coupling and shall be watertight when assembled. In addition, the Contractor shall adhere to any additional Host Base/site specific requirement.

2.2.11.4. Installation

Installation of underground conduits/ducts shall be IAW RUS Bulletin 1751F-643 and RUS Bulletin 1753F-151. Ducts installed beneath roads, sidewalks, parking areas, other paved surfaces or areas to be paved, etc. shall be installed a minimum of 36" below grade. In a MH with knockouts, ducts shall start at the bottom knockout, allowing for upward expansion in the

MH. All ducts not installed under roads, sidewalks, parking areas, or areas to be paved, etc. shall have a minimum of 36 inches ground cover, where possible. The Contractor shall provide other protective measures, concrete cap, etc., in those areas where the minimum ground cover cannot be achieved. Grading of ducts shall be accomplished IAW RUS Bulletin 1751F-643. All conduits shall be continuous between MH/HHs (i.e., no breaks or separations in the conduit runs between MH/HHs).

2.2.11.5. Bends and Sealing

All bends between MHs shall be a minimum of ten times (10X) the diameter of the duct size (i.e., 4-inch duct = 40 inches) with the sum of bends in all directions not exceeding a total of 90 degrees, where practical. Coordinate with 17 CS/SCXP if runs have bends that total more than 90 degrees is required. Ducts shall have bell-ends and enter a MH perpendicular to the surface of the wall through which it is entering. All ducts/inner-ducts entering MH shall be sealed. Universal duct plugs or removable putty sealants may be used. Upon completion of conduit sections, a rigid 12" long test mandrel ¼" (6.4mm) smaller than the inside diameter of the conduit shall be pulled through two diagonally opposite ducts to ensure proper alignment. In addition, all ducts shall be cleared of loose materials such as concrete, mud, dirt, stones, etc.

2.2.11.6. Utility Separation

When communications ducts cross either power duct or buried power cable, maintain a minimum separation of 3 inches of concrete or 12 inches of well-tamped earth between the two or 12 inches of well tamped earth when parallel; for pipes (e.g., gas, water, oil) maintain 6 inches when crossing or 12 inches when parallel.

2.2.11.7. Spacers and Tracer Wire

Along the length of the duct run, if the ducts are installed by trenching, spacers shall be placed at five (5) foot intervals and cable warning tape shall be buried one (1) foot above the conduit and shall follow the duct route. The tape shall be a minimum of three inches wide and orange in color with the appropriate warning message. At least one duct shall have tracer wire or be otherwise locatable from the surface.

2.2.11.8. Entrance Conduits into Existing Maintenance Holes

When new entrance conduits/ducts or sleeves are required, the Contractor shall bore and install the necessary holes and install the ducts or sleeves, if a knockout does not exist. Penetration shall not be in such a location through the wall as to block use of existing ducts in the maintenance hole. New ducts will be a minimum of 18 inches from either the maintenance hole floor or ceiling, if practical. The minimum bending radius for entry conduit/ducts shall be no less than 10 times the inside diameter of the conduit. Ducts and openings around ducts shall be sealed to prevent moisture from entering the maintenance holes.

2.2.11.9. Excavation/Building Penetrations

All wall penetrations, including inside buildings, shall be restored to meet the required base fire ratings.

2.2.12 N/A

2.2.13. Outside Plant Installation

This section describes the underground cables, flexible geotextile multiple cell fabric, innerduct and MH/HH plus conduit system installation requirements. The Contractor shall design and install Customer-Owned Outside Plant Telecommunications Infrastructure in accordance with ANSI/TIA-758 and 17 CS SOP. Each cable installation shall be coordinated with 17 CS/SCXP so that the impact on the building users is properly coordinated. The sequence of installation is at the Contractor's discretion.

2.2.13.1. Infrastructure Installation

The Contractor shall install the following new infrastructure: 2 x 4" outdoor rated conduits approximately 150 feet, on dirt or roadway, one 3x3 inch Geo-textile fabric approximately 320 feet, one (1) 24 port FODP. Additionally, 260 feet of 24 strand single mode corning glass fiber, and 260 feet of 100 pair copper cabling. (Coordinate exact location with 17 CS/SCXP).

2.2.13.1.1. Maintenance Holes

New maintenance hole or hand hole will not be needed for this project.

2.2.13.1.2. Ductbank Infrastructure

Install 4" PVC and/or HDPE 11.5 duct banks IAW with the following table.

From Building	To Bldg. or Mole	Quantity	Approx. Distance (Feet)	Figure	Comment
B3321	MH-301	2	150	1	2 X 4" outdoor rated conduit
B3321	B3321	2	50	1	2 X 4" EMT

2.2.13.1.3. Geo-textile Fabric Installation

Install geo-textile fabrics IAW the following table

From Building	To Bldg. or Mole	Quantity	Approx. Distance (Feet)	Figure	Comment
B3321	MH-301	1	320	1	Install one-3x3" Geo-textile fabrics (detectable)

2.2.13.2. Fiber Optic Cable Installation

Install outside plant FOC as described in the following paragraphs. The cable shall be all dielectric, loose buffer tube, water blocked, single mode, corning glass, outside plant (OSP) cable suitable for indoor/outdoor applications. The Contractor shall coordinate each cable installation

with the 17 CS/SCXP so as to minimize the impact on building users. The intent is to install the cable in one continuous length, to the extent that it is practical. The Contractor shall determine whether there is some practical reason for an intermediate splice in the cable at some maintenance hole/handhole between the cable end points. If an underground splice is necessary, it shall be accomplished IAW commonly accepted telecommunications industry practices for fusion splicing optical fiber cable and sealed with a splice case suitable for the application. If a splice case is installed in a maintenance hole/handhole it shall be pressure tested IAW the manufacturer's instructions. If a splice case leaks, it shall be reinstalled and retested. A coil of 50 feet of cable shall be provided on each cable entering or leaving a splice case in a maintenance hole or handhole and approved by 17 CS/SCXP.

Install Outside Plant Cabling IAW the following Table:

From Building	To Bldg or MHole	Cable Size	Approx. Distance (Feet)	Figure	Comment
B3321	MH-301	24 Strand SM	260	1	Indoor/Outdoor rated FOC IAW 17 CS SOP
B3321	MH-301	100 Pair	260	1	Outdoor rated Copper Cabling IAW 17 CS SOP

2.2.13.2.1. Fiber Optic Cable from B3321 to MH-301

The Contractor shall install approximately 260 feet of one continuous length, 24-strand SM FOC from B3321 to MH-301 utilizing existing and new Maintenance Hole Ductbank System. Length of run in SOO is an estimate and shall be verified by contractor. The contractor shall also install the following at B3321 and/to MH-301:

- Install outdoor/indoor rated fiber optic cable.
- At B3321, One (1) 2U, 24-size fiber optic distribution panel, along with cassette style fiber panels. Verify placement with 17 CS.
- At B3321, Fusion Splice 24-strand SM fiber optic cable to pre-factory certified pigtailed in cassette style fiber panels.
- At B3321, OTDR and Power Meter/Light Source test in both directions to B3311
- Label all FODP's and FOC per 17 CS Standard Operating Procedures.
- Provide one (1) CAD drawings for all work performed.
- MHDS templates can be provided at the appropriate time in the project.

2.2.13.2.2. Copper Cable from B3321 to MH-301

The Contractor shall install approximately 260 feet of one continuous length, 100 Pair Copper Cable from B3321 to MH-301 utilizing existing and new Maintenance Hole Ductbank System. Length of run in SOO is an estimate and shall be verified by contractor. The contractor shall also install the following:

- Contractor will transition from outdoor rated to indoor rated cabling in mechanical room to meet TIA Standards. Terminate at new Telecomm Room. Placement shall be provided by 17CS.

- At B3321, One (1) 100 Pair Building Entrance Terminal. Verify placement with 17CS.
- At B3321, Splice 100 pair copper on 710 Module Type connectors in existing stainless steel type splice case.
- At B3321, Test 100 pair in both directions. Contractor will only be responsible for cabling installed on this contract.
- Label BET and Copper Cabling per 17 CS Standard Operating Procedures.
- Provide one (1) CAD drawings for all work performed.
- MHDS templates can be provided at the appropriate time in the project.

2.2.13.2.3. Building 3321

Building 3321 is a to be Fire Station living quarters Building and contains no existing telecomm room. Contractor will build a new Telecomm Room at desired location in East Wing. Provide new metal stud walls with 5/8” sheetrock, taped, floated, textured to match existing and painted with 1 coat primer and 2 coats paint to match existing. Walls will extend from existing floor to existing suspended ceiling. Will enclose closet and provide new 18 gauge, 1 3/4” thick hollow metal door with 16 gauge, 2”x5 3/4” throat depth, hollow metal frame with three hinges per door, minimum. A minimum of three jamb anchors per jamb and a minimum of three rubber silencers per strike jamb. Doorstops are required if door swing has the potential of creating wall damage. Door shall have 1 coat primer and 2 coats paint to match existing doors and frames with lock sets and latch sets that meet ANSI/BHMA A156.2, series 4000, grade 1, bored type with levers. Lock sets and latch sets shall be capable of accepting “Best” removable cores. Provide rubber cove base to match existing. Rubber base shall be continuous roll, 1/8"x4” thick base. Vinyl base is not allowed under any circumstances. Contractor shall engineer, furnish, install, and test fourteen quad telecomm outlets. Each outlet will have two green non shielded CAT 6 cables, one RG-6 Coaxial Cable, and one blank insert. Contractor shall transition 100 pair copper cable to new enclosure cabinet. Additional details for this task can be provided during site survey or as needed by 17 CS SCXP. New Telecommunications Room and Inside plant wiring shall, at a minimum, meet all UFC 3-580-01, Ch.1 & 2, 17 CS SOP, and GAFB Base Standardization requirements. See Figure 2.

TASK	QTY
Build new Telecommunications Room. Install two walls, lockable full-size door, anti-static flooring, and provide appropriate cooling temperature. Install three sheets of 4' X 8' 3/4-inch fire-rated plywood backboard on wall. Mount two (2) 19-inch relay racks with base insulator kit. Include two single sided vertical and eight single sided horizontal wire management. Install 12-inch ladder racking to achieve cabling pathway and provide three-point bracing to meet seismic zone 4 requirements. Install TMGB using all UL listed materials, bond rack, ladder rack, and building entrance terminal with number six green stranded wire and two-hole lugs for bonding connections. Install # 2 wire from TMGB to building electrical service ground. Install one dedicated circuit on a duplex 20 Amp-120 Volt AC, non-switch electrical outlet and one convenience outlet in close proximity to rack. Install 20 Amp-120 Volt-Surge	1

Suppressed Horizontal Power distribution on the 19-inch rack. Install seismic relay rack with vert wire managers, isolation pad, power strip, and heavy-duty relay rack shelf base capable of housing a 100lb Uninterrupted Power Supply in each rack. Installation shall meet all ANSI/TIA/EIA 568 standards and UFC 3-580-01.	
Provide and install Cat-6, 48 port patch panels for NIPR Terminations.	2
Provide and install two green Cat-6 plenum cables, one RG-6 coaxial cable, and one blank insert, up to 295' to support network services from the existing TR (Telecom Room) to specified work area. Termination method shall be 568B type wiring configuration to support NIPR Services.	14
Provide appropriate size, green or white Cat-6 Patch Cords.	56
Provide CAD Services and Provide (1) Hard Copy 24" X 36" CAD Drawing	1

2.2.14. Site Restoration/Debris Removal

The Contractor shall restore all disturbed grounds to the “as found” condition or better after installation. Base grounds restoration requirements shall be complied with. Common use areas shall be restored to their original condition. The Contractor shall be responsible for disposing of all residues from this project off base and in accordance with Federal, state and base environmental laws and regulations. All residue produced by directional drilling operations (i.e., slurry) shall be disposed of off base on the same day the residue is produced, at an appropriate disposal facility at the contractor’s expense, IAW federal, state, local and Goodfellow AFB environmental laws and regulations. Under no circumstances will the contractor stage or store boring residue in slurry ponds or other containment areas on Goodfellow AFB.

2.2.15. Service Outages

The Contractor shall be responsible for preventing any unscheduled (i.e. cutting or disabling any in-service cables or equipment.), Contractor-caused, interruptions of communications capabilities that are properly identified. The Contractor shall coordinate planned outages with the site POC at least 10 calendar days in advance of the outage if the implementation necessitates disruption of service, (e.g., communications, electrical, or other utilities).

2.2.16. Identification/Marking

The Contractor shall clearly mark all Contractor-Furnished Property and Equipment (CFP/CFE) with their company's name. The Contractor shall place an easily read, very visible, sign (minimum 8.5 inches x 11 inches) on large containers, construction equipment, or un-manned rental vehicles while on the Government installation indicating the company name and both the Contractor and Site POC's names and local telephone numbers.

2.2.17. Installation Schedules

The Contractor shall provide a complete milestone schedule that denotes project activities to include time-phased start and completion dates for the project and sub-projects associated with the installation of the components and system. (CDRL A002)

2.2.18. Weekly Status Reports

The Contractor shall prepare a Weekly Status Report in English and shall distribute. The purpose of the report is to inform IPT members of project progress, problems being encountered,

and other topics necessary/beneficial to ensure success and timely completion of the contract requirements. (CDRL A003)

2.2.19. As-Built Drawings

The Contractor shall submit red line drawings showing the “as-built” configuration in format specified by base SCX project manager. The base communications squadron will provide baseline drawings. The Contractor shall provide As-Built Rack Elevation, Inside Cable Plant and Outside Cable Plant drawings and distribute per Goodfellow Air Force Base, Standard Operating Procedures. (CDRL A001)

2.2.20. Test and Acceptance/Installation Test Plan

The Contractor shall provide a test plan as to how the system shall be pre-tested, in-progress-tested and post-tested to demonstrate to the Government that the system is fully operational ready to be placed into service. The Contractor shall test the system to demonstrate to the Government quality assurance representative. These tests shall be accomplished prior to the system being placed into service. (CDRL A005)

2.2.20.1 Outside Plant Cable testing

All strands of fiber optic cables shall be tested IAW TIA 526-7 Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant, or equivalent. As a minimum, the following tests shall be performed. Both Optical Time Domain Reflectometer (OTDR) and Optical Power Meter tests will be used for all end-to-end circuits. Between FODPs, bi-directional testing at 1310 nm and 1550 nm is required.

NOTE: Testing of the Fiber Optic Cables on the reel shall be provided to the 17 CS/SCXP prior to installation.

2.2.21. Acceptance/Installation Test Report

The Contractor shall provide an installation test report of the results of the testing accomplished under the installation test plan IAW CDRL A006.

2.2.22. Final Acceptance

The Contractor shall schedule a final project walk-through with the 17 CS/SCXP. This should be scheduled 10 calendar days prior to acceptance.

2.2.23. As-Built Documentation in CVC

The Contractor shall record geospatial data and provide as-built documentation (shape files) of all new installed maintenance hole system components (including metadata) compatible with the Cyberspace Infrastructure Planning System (CIPS) Visualization Component (CVC) drawing system. Data points shall be recorded at the center of each manhole/handhole lid and at intervals not to exceed 25 feet along cable routes. Sufficient data points shall be recorded to capture any change in direction along the route. All GPS coordinates shall have +/- 3 feet accuracy for all readings. The government is responsible for providing the Contractor with a copy of the installation’s most current GeoBase Common Installation Picture (CIP), and current CVC drawings of the areas of interest. The government will review the shape files in CVC and transcribe the information to the CVC system. Shape files shall be delivered upon project completion. (CDRL A001)

3. GENERAL INFORMATION

3.1. Period of Performance

The period of performance for the project shall be determined based on the proposed schedule and actual contract award date.

3.2. Place of Performance

The place of performance is Goodfellow AFB, TX.

3.3. Hours of Operation

The Contractor shall routinely work during normal duty hours of the site. However, mission requirements may necessitate work outside normal hours (nights and/or weekends), especially if existing service must be interrupted. Any site work requested by the Contractor to be performed outside of normal duty hours shall be coordinated with the 17 CS/SCXP and approved by the Contracting Officer at least 10 calendar days in advance.

3.4. Holidays/Down Days

The Contractor shall not perform under this contract on federal holidays or site-unique down-days unless expressly authorized by the CO and coordinated with the 17 CS/SCXP Project Manager.

3.5. Base Support

The Contractor shall identify any base support requirements (for example, laydown and storage areas) necessary to complete this project in their proposal. The contractor shall return all government furnished lay-down and storage areas to their original condition upon completion of the project.

3.6. Minimum Contractor Qualifications.

All work shall be performed by an experienced Telecommunications Contractor. The Contractor shall have a minimum of 3 years of experience in Telecommunications Systems installations and provide the technician's certifications that are to perform work on this project.

APPENDIX A: APPLICABLE STANDARDS

The following list is not all-exclusive. The Contractor shall comply with applicable commercial code and standards

AFI 91-203 – Air Force Consolidated Occupational Safety Instruction

AFBAN-FS – AF Base Area Network Functional Specification, 2017

OSHA CFR 29 Part 1910-268 – Telecommunications

NEMA TC 2- Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

ANSI/TIA-606-B Administration Standard for Telecommunications Infrastructure

TIA-568-C Commercial Building Telecommunications (568C.1, 568C.2, 568C.3) Cabling Standard

ANSI/TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces

TIA-570-C –Residential Telecommunications Infrastructure Standard

TIA-758 - Customer-owned Outside Plant Telecommunication Infrastructure Standard

T.O. 00-33A-1001, Methods and Procedures, General Cyberspace Support Activities Management Procedures and Practice Requirements

BICSI TDM Manual - Building Industries Consulting Services International Telecommunications Distribution Methods (TDM) Manual

BICSI – Outside Plan Design Reference Manual

RUS Bulletin 1751F-643 - Underground Plant Design

RUS Bulletin 1751F-644 - Underground Plant Construction Telecommunications Engineering Shield Continuity and Construction Manual (TE&CM) 451.2

RUS Bulletin 1751F-801 – Electrical Protection Fundamentals

RUS Bulletin 1753F-151 (515b) - Specifications and Drawings for Underground Cable Installation

NFPA 70 - National Electric Code

FGDC-STD-007.3-1998 - Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy

UFC 3-520-01. Interior Electrical Systems

UFC 3-580-01, Telecommunications Interior Infrastructure Planning and Design (Ch. 1 & 2)

17th CES/CEN, Base Standardization

Goodfellow Air Force Base Telecommunications Requirements (17 CS, SOP)
40CFR61, Sub Part M, National mission Standards for hazardous Air Pollutants Compliance (NESHAP)

APPENDIX B: LIST OF DELIVERABLES

All deliverables are subject to Government acceptance and approval. They shall meet professional standards and the requirements set forth in this SOO. All deliverables shall be produced using recommended software tools/versions as accepted by the Government. The Contractor shall submit the following deliverables:

CDRL	Data Item Title	Data Item Title
A001	As Built	
A002	Work Schedule	
A003	Status Report	
A004	Meeting Minutes	
A005	Test Plan	
A006	Test Report	

APPENDIX C: LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AFM	Airfield Management (BaseOPS)
Approx	Approximately
ATC	Air Traffic Control Tower
ATCALs	Air Traffic Control and Landing Systems
BCE	Base Civil Engineering
CDRL	Contract Deliverable
CFE	Contractor-Furnished Equipment
CFP	Contractor-Furnished Property
CIP	Common Installation Picture
CIPS	Cyberspace Infrastructure Planning System
CMA	Controlled Movement Area
CMHDS	Communications Maintenance Hole Duct System
CO	Contracting Officer
Comm	Communications
CS	Communications Squadron
CSI-B	Cyberspace Integrator-Base
CVC	CIPS Visualization Component
ECMRA	Contractor Manpower Reporting Application
EFI&T	Engineer, Furnish, Install and Test
FOC	Fiber Optic Cable
FODP	Fiber Optic Distribution Panels
FOUO	For Official Use Only
FY	Fiscal Year
HDPE	High Density Polyethylene
HH	Hand Hole
IAW	In Accordance With
ID	Inside Diameter
ILS	Instrument Landing System
IPT	Integrated Process Team
ITB	Information Transfer Building
LMR	Land Mobile Radio
MH	Maintenance Hole
MHDS	Maintenance Hole Duct System
NLT	No Later Than
NPDES	National Pollution Discharge Elimination System
OEM	Original Equipment Manufacturer
OPSEC	Operational Security
OSHA	Occupational Safety & Health Administration
OSP	Outside Plant
OSS	Operations Support Squadron
OTDR	Optical Time Domain Reflectometer
PDF	Portable Document Format
PM	Project Manager
POC	Point Of Contact
Prime	Prime Contractor

PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
QAE	Quality Assurance Evaluator
QCM	Quality Control Manager
Qty	Quantity
RUS	Rural Utilities Service Bulletin
SCOW	Supply Chain Operations Wing
SCX	Scheduler Planner
SE	System Engineer
SM	Single Mode
SOO	Statement of Objectives
Sub	Sub-Contractor
SWPPP	Storm Water Pollution Prevention Plan
TIA	Telecommunications Industry Association
TMGB	Telecommunication Main Ground Bus-Bar
TRD	Technical Requirements Document

APPENDIX D: DRAWINGS

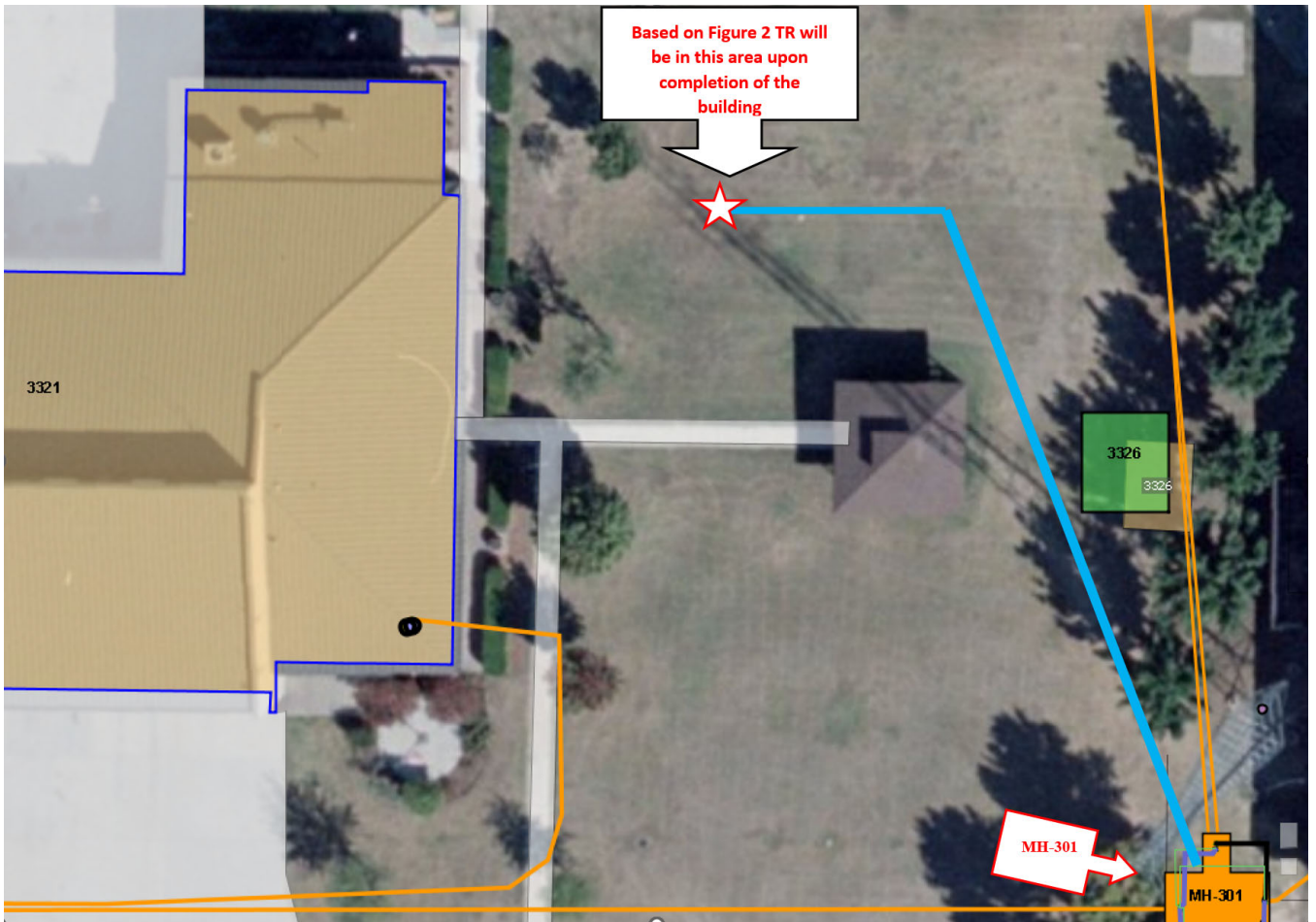


Figure 1: Proposed ISP/OSP Route

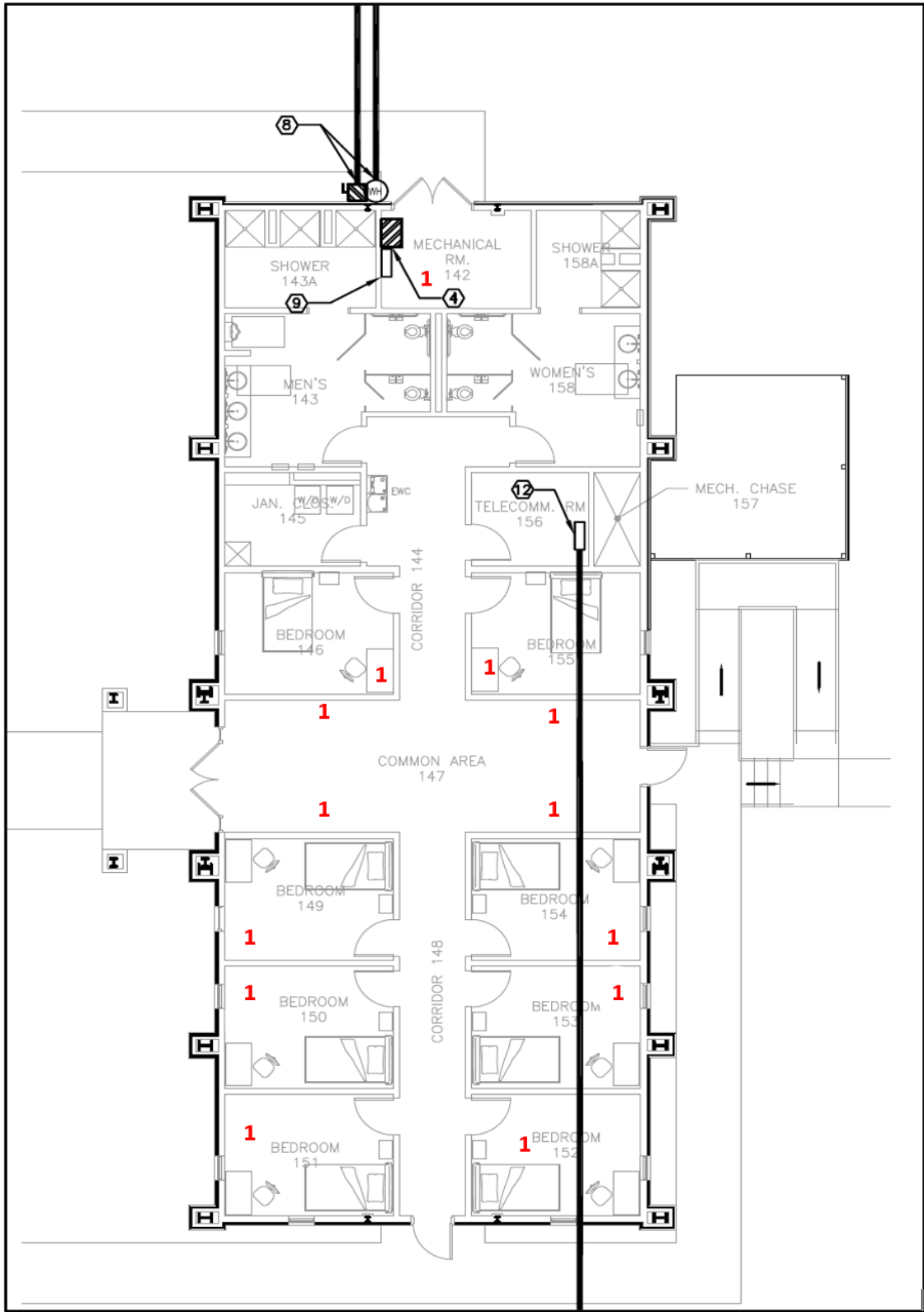


Figure 2: Proposed ISP

SECTION 275126 - MASS NOTIFICATION SYSTEM

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 within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 72	(2006; Errata 2008; Errata 2009) National Fire Alarm Code

UNDERWRITERS LABORATORIES (UL)

UL 1242	(2006; Rev thru Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 797	(2007) Standard for Electrical Metallic Tubing -- Steel
UL 864	(2003; Rev thru May 2007) Control Units and Accessories for Fire Alarm Systems

1.2 SUBMITTALS

- A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-02 Shop Drawings
 - a. Mass Notification System
 - b. Detail drawings 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 devices. 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 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. SD-03 Product Data
 - a. Storage Batteries

- Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.
- b. Voltage Drop
 - Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.
- c. Special Tools and Spare Parts
 - Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.
- d. Technical Data and Computer Software
 - Technical data which relates to computer software.
- e. Training
 - Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated Government personnel with proper operation of the mass notification system. The maintenance training course shall provide the designated Government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.
- f. Testing
 - Detailed test procedures for mass notification system 60 days prior to performing system tests.
- 3. SD-06 Test 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.
- 4. SD-07 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
 - NFPA and/or NICET certifications showing proof of qualifications for required personnel. The installer shall submit proof of experience for the technician and the installing company.
- 5. SD-10 Operation and Maintenance Data
 - a. Technical Data and Computer Software
 - Six copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their

basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

1.3 GENERAL REQUIREMENTS

A. Standard Products

1. 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.

B. Nameplates

1. 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.

C. Keys and Locks

1. Locks shall be keyed alike. Four keys for the system shall be provided.

D. Tags

1. Tags with stamped identification number shall be furnished for keys and locks.

E. Verification of Dimensions

1. After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

F. Compliance

1. The equipment furnished shall be in full compliance with UFC 4-021-01 and compatible with UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable standards.

1.4 QUALITY ASSURANCE

A. Qualifications

1. Installer
 - a. The installing Contractor shall provide the following: The mass notification technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.5 SYSTEM DESCRIPTION

A. Operation

1. The mass notification system shall be a complete, supervised mass notification system. The system shall consist of an autonomous control unit to monitor and control the notification appliance network and provide consoles for local operation. Using the console, personnel in the building shall be able to initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe notification appliances. With the Building Fire Alarm in the alarm state, the autonomous control unit shall temporarily deactivate audible fire alarm notification appliances while delivering voice messages to ensure the voice messages are intelligible. Textual, audible, and visual appliances and systems shall comply with NFPA 72. Mass notification system

components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. System shall provide the following features:

- a. Sufficient capacity to perform as specified.
- b. UL864, MEA, CSFM, CUL, FCC PART 15, CE approved. OSHA 1910.165 compliant and ADA compliant.
- c. Supervised notification appliance circuit and expansion equipment circuits.
- d. Four digitally pre-recorded voice messages can be automatically triggered. Contents of the messages shall be obtained by from the Contracting Officer.
- e. Built-in 24V dc power supply and charger.
- f. Fully supervised on-board diagnostics and trouble reporting circuits.
- g. 70.7V amplifier and expansion amplifiers

B. Operational Features

1. The system shall have the following operating features:
 - a. Monitor electrical supervision of IDC, SLC, and NAC.
 - b. Monitor electrical supervision of the primary power (ac) supply, battery voltage.
 - c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition preventing the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage. 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.
 - d. Capacity for a minimum of four pre-recorded messages. The minimum time allowable for the four messages shall be one minute.
 - e. Live microphone override from the operator console. A Key shall be required for Microphone operation.
 - f. Ability to function connected to a base-wide control system and/or as an independent building system. The building mass notification system shall be completely operable without a base-wide system installed and operate independently of any other system in the building. The system shall be able to send all trouble signals to the base-wide control system. The connection between the Mass Notification system and the base-wide system devices shall be able to be electrically supervised.
 - g. The system shall deactivate fire alarm audible notification appliances while delivering voice messages and then, reactivate the fire alarm audible notification appliances. Deactivation of the fire alarm audible notification appliances shall occur only when both the fire alarm panel is in alarm condition and a voice message is to be transmitted by the mass notification system. Only the fire alarm system audible notification appliances shall be deactivated. All other features of the fire alarm system, including the operation of visual notification devices and transmission for signals to the fire department, shall remain unaffected. Deactivation of fire alarm audible notification appliances shall cause a separate supervisory signal in the fire alarm system and transmit to central receiving station. Visual annunciation of separate supervisory signal shall be distinctly labeled or otherwise clearly identified.
 - h. The system shall have adequate discrete outputs to temporarily deactivate fire alarm audible notification appliances, initiate optional textual displays, and initiate/synchronize strobes.

- i. The system shall have the ability to automatically repeat selected pre-recorded messages until terminated.

C. Alarm Functions

1. An alarm condition on a circuit shall automatically initiate the following functions:
 - a. Deliver either the selected one of the 4 distinct pre-recorded voice messages or a live voice messages from the secure microphone.
 - b. Activate visual (strobe) mass notification appliances throughout the building when one of the pre-recorded messages or a voice message is activated.
 - c. Deactivation of the fire alarm audible notification appliances throughout the building.

D. Primary Power

1. Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the mass notification system upon operation of any initiating circuit.

E. Battery Backup Power

1. Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

F. Interface with Fire Alarm Equipment

1. The equipment specified herein shall be separate from the fire alarm system. The mass notification system equipment shall be interfaced/connected to the fire alarm system to deactivate the fire alarm audible notification appliances. The deactivation of the fire alarm audible notification appliances shall cause a supervisory signal at the fire alarm control panel.

1.6 TECHNICAL DATA AND COMPUTER SOFTWARE

- A. Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

1. Identification of programmable portions of system equipment and capabilities.
2. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
3. Provision of operational software data on all modes of programmable portions of the mass notification system.
4. Description of MNCP equipment operation.
5. Description of auxiliary and remote equipment operations.
6. Library of application software.
7. Operation and maintenance manuals as specified in Submittals paragraph.

1.7 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.

2.1 AUTONOMOUS CONTROL PANEL

- A. Control Panel shall be equal to Monaco Multi-Circuit Mass Notification Panel. Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate any alarm, supervisory or trouble condition on the system. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and id number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted gray.
- B. Power Amplifier
1. Power amplifiers as a minimum conform to the following specifications:
 - a. Rated power output: As shown in watts RMS
 - b. Frequency Response Music: Plus or Minus 3 dB, 100-15,000 Hz
 - c. Frequency Response Voice Override: Plus or Minus 3 dB, 275-6,500 Hz
 - d. Distortion: Less than 2 percent at RPO, 600-13,000 Hz
 - e. Input: As required by system and 1 Aux
 - f. Output voltage: 25 and 70.7 volts
 - g. Power Requirement: 110-125 Vac 60 Hz
- C. Visual Notification Power (Strobes)
1. The visual notification power unit shall be sized for a minimum of 10% greater power than required for the number of strobes shown.
- D. Circuit Connections
1. Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.
- E. System Expansion and Modification Capabilities
1. Any equipment and software needed by qualified technicians to implement future changes to the mass notification system shall be provided as part of this contract.

2.2 REMOTE MICROPHONE AND CONTROL (OPERATOR CONTROL)

- A. The remote microphone shall be a supervised hand held push to talk microphone and a key shall be required to enable remote microphone use. Removable wiring terminals for quick connect/disconnect accepting 12 - 22 AWG shall be incorporated. All output circuitry shall be power limited. Individual front panel LED's shall be provided for indication of System Normal, System Trouble and Alarm. Multiple on

board diagnostic LED's shall be provided. Remote microphone usage shall disengage background music and general paging. Voice frequency response shall be 275 Hz - 6.5 kHz +/- 2.4 dB. Power requirements shall be 24VDC and will be supplied by the Autonomous Control. There shall be controls for start and stop of the four pre-recorded messages. The mounting plate shall be red and measure 8 3/4" x 5 1/4", and shall fit into a 4 gang back box.

2.3 STORAGE BATTERIES

- A. Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the mass notification system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located in a separate battery cabinet. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the mass notification control panel.

2.4 BATTERY CHARGER

- A. Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

2.5 NOTIFICATION APPLIANCES

- A. 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 white. Recessed audible appliances shall be installed with a grill that is painted white.

B. Speakers

1. Speakers shall be capable of operating at 70.7 nominal Vrms. Speakers shall be compliant with UL 1480 for protective signaling systems. Power taps shall be selectable by shunts.
2. Interior Speakers
 - a. The interior speakers shall be 8" (eight inch) Supervised UL 1480 Listed Ceiling Speaker shall be mounted to a round white epoxy painted metal 12" grille with a 70 volt multi-tap transformer. The wattage taps shall range from ¼ watts to 5 watts. The speaker cone shall be flame retardant. The frequency response shall be 60 Hz - 12 kHz +/- 2.4 dB, reverberant per UL 1480 shall be 400 - 4 kHz +/- 2.4 dB. The sensitivity shall be 78 dB at 10 feet with ¼ watts of source power input, 81 dB at 10 feet with ½ watt of source power input, 84 dB @ 10 feet with 1 watt of source power input, 87 dB at 10 feet with 2 watts of source power input, and 90 dB at 10 feet with 5 watts of source power input. The magnet weight shall be 10 oz. and shall be made of barium ferrite ceramic. The speaker impedance shall be 8 ohms. The voice coil diameter shall be 1". Interior speakers installed recessed shall be provided with back box, flanges and required accessories for installation in appropriate ceilings. Surface mounted speakers shall be suitable for such use and shall be provided with appropriate mounting hardware and back box. Speaker circuits shall be supervised.
3. Exterior Speakers
 - a. Exterior speakers shall be of the weatherproof horn loudspeaker type, weather-resistant metal construction and protected against water, humidity, vermin and corrosion. Exterior speakers shall be provided with mounting hardware to allow directional sound dispersion via vertical and horizontal positioning. The horn shall be able to operate within any ambient temperature ranging from 66 degrees C (150°F) to -35 degrees C (-30°F). The horn shall be a 15 watt RMS audio power rated compression driver producing a UL rated 102 dB measured at 15 watts at 10 feet. The horn shall have an impedance selection via a 7 position switch of 5000, 2500,

1300, 666, 333, 89 & 45. Power taps shall be available at .9, 1.8, 3.8, 7.5 & 15 watts for the 70 volt line. Each power tap shall have a 3dB incremental rating. The frequency response range shall be 400 - 14,000 Hz at 8 ohms. The horn assembly shall be furnished with a mounting bracket that allows adjustment on either a vertical or horizontal plane with a single locking pin and include provisions for mounting, banding or strapping. Wiring terminals shall be fully enclosed and a vandal-resistant adapter cover shall provide connection protection for cable or conduit. The horn shall be 7.875" W x 8.75" H x 9.313" D. The horn shall be finished in gray baked epoxy. A built-in capacitor shall be provided for line supervision.

C. Visual Notification Appliances

1. Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be semi-flush mounted. Mass notification strobes shall be marked "ALERT" and have amber colored lenses. Visual devices shall be synchronizable.

D. Voice System

1. The voice evacuation system shall provide for one-way voice communications, routing and pre-amplification of voice messages. System shall meet intelligibility as defined in NFPA 72. It should be measured in accordance with IEC 60849 and IEC 60268.

2.6 MASS NOTIFICATION SYSTEM PERIPHERAL EQUIPMENT

A. Conduit

1. Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

B. Wiring

1. Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The wiring shall be copper cable in accordance with the manufacturers requirements. Wiring for mass notification 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. 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 supervisory alarm circuits, and notification appliance circuits are prohibited.

C. Special Tools and Spare Parts

1. Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished.

3.1 INSTALLATION

- A. All work shall be installed as shown, and in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified.
- B. Power Supply for the System
 - 1. Provide a single dedicated circuit connection for supplying power from a branch circuit to each building mass notification system. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "MASS NOTIFICATION SYSTEM CIRCUIT CONTROL".
- C. Wiring
 - 1. Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the mass notification 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 mass notification system equipment manufacturer's representative shall be present for the connection of wiring to the control panel.
- D. Control Panel
 - 1. The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 1' nor more than 6' 6" above the finished floor. Manually operable controls shall be between 3' and 3' 8" above the finished floor. Panel shall be installed to comply with the requirements of UL 864.
- E. Notification Appliances
 - 1. Notification appliances shall be mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.
- F. Annunciator Equipment
 - 1. Annunciator equipment shall be mounted where indicated on the drawings.

3.2 OVERVOLTAGE AND SURGE PROTECTION

- A. Power Line Surge Protection
 - 1. All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).
- B. Low Voltage DC Circuits Surge Protection
 - 1. All cables/conductors shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

3.3 GROUNDING

- A. Grounding shall be provided by connecting to building ground system.

3.4 TESTING

- A. Notify the Contracting Officer at least 14 days before the performance and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. Furnish instruments and personnel required for the tests.

- B. Performance Tests

- 1. 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 mass notification equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the performance testing the Contractor shall complete a witnessed acceptance test of the mass notification system. Performance testing shall be spot-checked by local representatives and the authority having jurisdiction at the installation.

- C. Acceptance Test

- 1. Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete a witnessed acceptance test of the system. The test shall include all requirements of NFPA 72 and the following:
 - a. Test of each function of the control panel.
 - b. Test of each circuit in both trouble and normal modes.
 - c. Tests of each alarm initiating devices in both normal and trouble conditions.
 - d. Tests of each control circuit and device.
 - e. Tests of each alarm notification appliance.
 - f. Tests of the battery charger and batteries.
 - g. Complete operational tests under emergency power supply.
 - h. Visual inspection of wiring connections.
 - i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
 - j. Ground fault.
 - k. Short circuit faults.
 - l. Stray voltage.
 - m. Loop resistance.
 - n. Test of fire alarm (deactivation of fire alarm audible devices) interface and operation.
 - o. Voice intelligibility test of both live and pre-recorded messages.

3.5 TRAINING

- 4 Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training day (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions or modifications to the mass notification system.

END OF SECTION 275126

SECTION 283176 - INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:
 - 1. Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS
 - 2. Section 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
 - 3. Section 08 71 00.00 44 DOOR HARDWARE for door release and additional work related to finish hardware.
 - 4. Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(1989; R 1999) Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)
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FM GLOBAL (FM)

FM P7825a	(2005) Approval Guide Fire Protection
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002) IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
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IEEE C62.41.2	(2002) IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
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INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60268-16	(2003) Sound System Equipment - Part 16: Objective Rating Of Speech Intelligibility By Speech Transmission Index
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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7240-16	(2007) Fire Detection And Alarm Systems — Part 16: Sound System Control And Indicating Equipment
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2008) Life Safety Code, 2006 Edition
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NFPA 170	(2009) Fire Safety Symbols
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NFPA 241	(2009) Safeguarding Construction, Alteration, and Demolition Operations
NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 72	(2006) National Fire Alarm Code
NFPA 90A	(2008; Errata 2009) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 90	Private Land Mobile Radio Services

UNDERWRITERS LABORATORIES (UL)

UL 1480	(2003; Rev thru Dec 2006); Standard for Safety Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
UL 1638	(2001; Rev thru Oct 2008) Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling
UL 1971	(2002; Rev thru Oct 2008) Signaling Devices for the Hearing Impaired
UL 2017	(2008) Standard for Safety for General-Purpose Signaling Devices and Systems
UL 268	(2006) Standard for Smoke Detectors for Fire Alarm Signaling Systems
UL 268A	(2008) Smoke Detectors for Duct Application
UL 464	(2003; Rev thru Feb 2008) Standard for Audible Signal Appliances
UL 521	(1999; Rev thru Jul 2005) Heat Detectors for Fire Protective Signaling Systems
UL 864	(2003; Rev thru May 2007) Control Units and Accessories for Fire Alarm Systems
UL Electrical Construction	(2008) Electrical Construction Equipment Directory
UL Fire Prot Dir	(2009) Fire Protection Equipment Directory

1.3 DEFINITIONS

- A. Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions shall be defined as follows:
1. Analog/Addressable System: A system where multiple signals are transmitted via the same conduction path to a remote fire alarm control unit and fire alarm control panel, decoded and separated so that each signal will initiate the specified response.
 2. Interface Device: An addressable device that interconnects hard wired systems or devices to an analog/addressable system.
 3. Remote Fire Alarm and Mass Notification Control Unit: A control panel, electronically remote from the fire alarm and mass notification control panel, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm control panel.
 4. Fire Alarm and Mass Notification Control Panel (FACP/FMCP): A master control panel having the features of a fire alarm and mass notification control unit and fire alarm and mass notification control units are interconnected. The panel has central processing, memory, input and output terminals, video display units (VDUs), and printers.
 5. Terminal Cabinet: A steel cabinet with locking, hinge-mounted door that terminal strips are securely mounted.

1.4 SYSTEM DESCRIPTION

- A. Scope
1. This work includes completion of design and providing a new, complete, analog/addressable fire alarm and mass notification system as described herein. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation.
 2. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 72, ISO 7240-16, IEC 60268-16, except as modified herein. The system layouts on the drawings show the intent of coverage and are shown in suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.
- B. Technical Data and Computer Software
1. Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:
 - a. Identification of programmable portions of system equipment and capabilities.
 - b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
 - c. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.
 - d. Description of Fire Alarm Control Panel equipment operation.

- e. Description of auxiliary and remote equipment operations.
- f. Library of application software.
- g. Operation and maintenance manuals.

C. Keys

- 1. Keys and locks for equipment shall be identical. Provide not less than six keys of each type required. All keys and locks shall be mastered to a single key as required by the local AHJ.

1.5 SUBMITTALS

A. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

- 1. SD-02 Shop Drawings
 - a. Annotated catalog data, in table format on the drawings, showing manufacturer's name, model, voltage, and catalog numbers for equipment and components. Submitted shop drawings shall not be smaller than ISO A1.
 - b. Wiring Diagrams; G
 - Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals.
 - Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.
 - c. System Layout; G
 - Plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170, Fire Safety Symbols.
 - d. System Operation; G
 - A complete list of device addresses and corresponding messages.
 - e. Notification Appliances; G
 - Data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances, 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.
 - f. Amplifiers; G
 - Data to indicate that the amplifiers have sufficient capacity to simultaneously drive all notification speakers at the maximum rating plus 50 percent spare capacity. Annotate data for each circuit on the drawings.
 - g. As-Built Drawings

- Six sets of detailed as-built drawings. The drawings shall be prepared on uniform sized mylar sheets not less than 30 by 42 inches with 8 by 4 inch title block similar to contract drawings. Also, furnish one set of CD or DVD discs containing software back-up and CAD based drawings in latest version of AutoCadd and DXF format of as-built drawings and schematics. The drawings shall include complete wiring diagrams showing connections between devices and equipment, both factory and field wired. Include a riser diagram and drawings showing the as-built location of devices and equipment. The drawings shall show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings shall be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings shall be provided at the time of, or prior to the final acceptance test.
2. SD-03 Product Data
- UL or FM listing cards for equipment provided.
- a. Technical Data And Computer Software; G
 - b. Fire alarm control panel (FACP); G
 - c. Fire Alarm And Mass Notification Control Panel (FACP/FMCP); G
 - d. Printers; G
 - e. Video Display Unit (VDU); G
 - f. Terminal cabinets/assemblies; G
 - g. Manual stations; G
 - h. Transmitters (including housing); G
 - i. Batteries; G
 - j. Battery chargers; G
 - k. Smoke sensors; G
 - l. Thermal sensors; G
 - m. Wiring and cable; G
 - n. Notification appliances; G
 - o. Addressable interface devices; G
 - p. Graphic annunciator; G
 - q. Amplifiers; G
 - r. Tone generators; G
 - s. Digitalized voice generators; G
 - t. Firefighter telephone; G
 - u. Waterflow detectors; G
 - v. Tamper switches; G
 - w. Electromagnetic door holders; G
 - x. Remote fire alarm control units; G
 - y. Radio transmitter and interface panels; G
 - z. Digital alarm communicator transmitter (DACT); G
 - aa. Telegraphic transmitter; G
3. SD-05 Design Data
- a. System Operation; G
 - A complete description of the system operation in matrix format on the drawings.
 - b. Battery power; G
 - Battery calculations as required in paragraph Battery Power Calculations.
4. SD-06 Test Reports
- a. Field Quality Control
 - b. Testing Procedures; G
 - c. Smoke sensor testing procedures; G
5. SD-07 Certificates

- a. Installer
6. SD-09 Manufacturer's Field Reports
 - a. Mass Notification System
 - b. A unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information. Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.
7. SD-10 Operation and Maintenance Data
 - a. Operation and Maintenance (O&M) Instructions; G
 - b. Six copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package. Manuals shall be approved prior to training.
 - c. Original and backup copies of all software delivered for this project, on each type of CD/DVD media utilized.
 - d. Instruction of Government Employees
 - The installers training history for the employees involved with this contract.

1.6 QUALITY ASSURANCE

- A. Equipment and devices shall be compatible and operable with existing station fire alarm system and shall not impair reliability or operational functions of existing supervising station fire alarm system. The supervising equipment is existing and consists of the following brands and models: supervising station control panel, Monaco, and signal reporting components.
 1. In NFPA publications referred to herein, consider advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; interpret reference to "authority having jurisdiction" to mean the Contracting Offices Designated Representative (COR).
 2. The recommended practices stated in the manufacturer's literature or documentation shall be considered as mandatory requirements.
 3. Devices and equipment for fire alarm service shall be listed by UL Fire Prot Dir or approved by FM P7825a.
- B. Qualifications
 1. Design Services

Installations requiring completion of installation drawings and specification or modifications of fire detection, fire alarm, mass notification system, fire suppression systems or mass notification systems shall require the services and review of a qualified engineer. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

 - a. A registered professional engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of four years work experience in fire protection engineering.
 - b. A registered professional engineer (P.E.) in fire protection engineering.
 - c. Registered Professional Engineer with verification of experience and at least four years of current experience in the design of the fire protection and detection systems.

- d. A NICET Level 4 Fire Alarm Technicians.
 2. Supervisor
 - a. The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 4 Fire Alarm Technician shall supervise the installation of the fire alarm system/mass notification system. A Fire Alarm Technician shall have a minimum of 8 years of experience and supervise the installation of the fire alarm system/mass notification system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
 3. Technician
 - a. The installing Contractor shall provide the following: Fire Alarm Technicians with a minimum of four years of experience utilized to assist in the installation and terminate fire alarm/mass notification devices, cabinets and panels. 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.
 4. Installer
 - a. The installing Contractor shall provide the following: Fire Alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system/mass notification system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
 5. Test Personnel
 - a. The installing Contractor shall provide the following: Fire Alarm Technicians with a minimum of eight years of experience utilized to test and certify the installation of the fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
 6. Manufacturer's Representative
 - a. The fire alarm and mass notification equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training on the system being installed.
 7. Manufacturer
 - a. Components shall be of current design and shall be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein.
- C. Regulatory Requirements
1. Requirements for Fire Protection Service
 - a. Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM P7825a. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM P7825a. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.
 2. Mass Notification System

- a. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory for the intended use. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.
3. Testing Services or Laboratories
 - a. Fire alarm and fire detection equipment shall be constructed in accordance with UL Fire Prot Dir, UL Electrical Constructn, or FM P7825a.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.
- 1.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS
- A. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions shall include:
 1. "Manufacturer Data Package" as specified in Section 01 78 23.00 44 OPERATION AND MAINTENANCE DATA.
 2. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.
 3. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.
 4. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements.
 5. Software delivered for this project shall be provided, on each type of CD/DVD media utilized.
 6. Printouts of configuration settings for all devices.
 7. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.
- 1.9 EXTRA MATERIALS
- A. Repair Service/Replacement Parts
 1. Repair services and replacement parts for the system shall be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During guarantee period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.
 - B. Interchangeable Parts
 1. Spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the Contracting Officer at the time of the final acceptance testing.
 - C. Spare Parts
 1. Furnish the following spare parts and accessories:
 - a. Four fuses for each fused circuit

- b. Nine spare reams of paper for the system printer, plus sufficient paper for fire alarm acceptance tests
 - c. Three spare printer ribbons
 - d. Three break rods for manual stations
- D. Special Tools
- 1. Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Standard Products

1. Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory, such as UL or FM, and listed or approved for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least two years prior to bid opening.

B. Nameplates

1. Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:
 - a. FACPs
 - b. Automatic transmitter
 - c. Printer
2. Furnish nameplates to obtain approval by the Contracting Officer before installation. Obtain approval by the Contracting Officer for installation locations. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.2 GENERAL PRODUCT REQUIREMENT

- A. All fire alarm and mass notification equipment shall be listed for use under the applicable reference standards. Interfacing of Listed UL 864 or similar approved industry listing with Mass Notification Panels listed to UL 2017 or equal shall be done in a laboratory listed configuration, if the software programming features can not provide a listed interface control. If a field modification is needed, such as adding equipment like relays, the manufacturer of the panels being same or different brand from manufacturer shall provide the installing contractor for review and confirmation by the installing contractor. The installing contractor shall, as part of the submittal documents, provide this information.

2.3 SYSTEM OPERATION

- A. The Addressable Interior Fire Alarm and Mass Notification System shall be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864 Ninth Edition, and UL 2017. 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. The system may be placed in the alert mode by local microphones or remotely from authorized locations/users.
- B. Alarm Initiating Devices
 1. Connect alarm initiating devices to initiating device circuits (IDC), Style D to signal line circuits (SLC), Style 6 and installed in accordance with NFPA 72.
 - a. Alarm notification appliances shall be connected to Voice Notification System, 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 or exposed to fire at any point, all IDC, NAC and SLC will remain functional. Should the design or building layout preclude separation then a fire rated separation shall be provided in accordance with NFPA 72. The return portion of the loop shall be remote from the supply portion of the loop.
 - b. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until initiating device(s) are reset and the fire alarm

control panel is manually reset and restored to normal. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system/mass notification system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

C. Functions and Operating Features

1. The system shall provide the following functions and operating features:
 - a. The FACP/FMCP and fire alarm and mass notification control units, shall provide power, annunciation, supervision, and control for the system. Addressable systems shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.
 - b. Provide Style B initiating device circuits for conductor lengths of 10 feet or less.
 - c. Provide Style 6 signaling line circuits for the network.
 - d. Provide Style Z notification appliance circuits. The visual alarm notification appliances shall have the flash rates synchronized.
 - e. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
 - f. Provide an audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a trouble alarm silence feature that shall silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke sensor in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.
 - g. Provide a notification appliance silencing switch, that when activated, will silence the audible signal appliance, but will not affect the visual alarm indicator, the liquid crystal display, or the automatic notification of the fire department and central station service. This switch shall be overridden upon activation of a subsequent alarm.
 - h. Provide alarm verification capability for smoke sensors. Alarm verification shall initially be set for 30 seconds.
 - i. Provide program capability via switches in a locked portion of the FACP to bypass the automatic notification appliance circuits, fire reporting system, air handler shutdown, smoke control operation, and door unlocking features. Operation of this programming shall indicate this action on the FACP display and printer output.
 - j. Alarm, supervisory, and/or trouble signals shall be automatically transmitted to the fire department or a UL listed central station.
 - k. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
 - l. The system shall be capable of being programmed from the panels keyboard. Programmed information shall be stored in non-volatile memory.
 - m. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.
 - n. There shall be no limit, other than maximum system capacity, as to the number of addressable devices, that may be in alarm simultaneously.

- o. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system a smoke control system, the addressable fire alarm relay shall be within 3 feet of the emergency control device.
- p. An alarm signal shall automatically initiate the following functions:
 - Transmission of an alarm signal to the fire department or a UL listed central station.
 - Visual indication of the device operated on the fire alarm control panel (FACP), and on the graphic annunciator. Indication on the graphic annunciator shall be by zone and type of device.
 - Continuous actuation of all alarm notification appliances, except those in stairs.
 - Recording of the event via the system printer and electronically in the history log of the fire control system unit.
 - Release of doors held open by electromagnetic devices.
 - Operation of the smoke control system.
 - Release of power to electric locks on doors that are part of the means of egress.
 - Operation of a duct smoke sensor shall shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph.
 - Operation of an interface, that operates vibrating pagers worn by hearing-impaired occupants.
- q. A supervisory signal shall automatically initiate the following functions:
 - Visual indication of the device operated on the FACP, and on the graphic annunciator, and sound the audible alarm at the respective panel.
 - Transmission of a supervisory signal to the fire department or a UL listed central station.
 - Recording of the event via the system printer and electronically in the history log of the fire control system unit.
- r. A trouble condition shall automatically initiate the following functions:
 - Visual indication of the system trouble on the FACP, and on the graphic annunciator, and sound the audible alarm at the respective panel.
 - Transmission of a trouble signal to the fire department or a UL listed central station.
 - Recording of the event via the system printer.
- s. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACP shall be 10 seconds.
- t. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP shall not exceed 200 seconds.

2.4 SYSTEM MONITORING

A. Valves

- 1. Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, isolating valves for pressure type waterflow or supervision switches, and valves at backflow

preventers, whether supplied under this contract or existing, shall be electrically monitored to ensure its proper position. Each tamper switch shall be provided with a separate address.

2.5 MASS NOTIFICATION SYSTEM FUNCTIONS

A. Notification Appliance Network

1. The notification appliance network consists of audio speakers located to provide intelligible instructions at all locations in the building. The Mass Notification System announcements shall take priority over all other function of the system including the audible and visual output of the fire alarm system in a normal or alarm state. All fire alarm system functions shall continue in an alarm state except for the output signals of the audible and visual notification appliances.

B. Strobes

1. Strobes are also provided to alert hearing-impaired occupants.

C. Text Displays

1. LED text displays for hearing impaired occupants.

D. Giant Voice

1. The Giant Voice system (if available) in the area of the building shall be activated to provide a pre-recorded live voice message.

E. Voice Notification

1. An autonomous voice notification control unit is used to monitor and control the notification appliance network and provide consoles for local operation. Using a console, personnel in the building can initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and (optional) textual message notification appliances. The autonomous voice notification control unit will temporarily override audible fire alarm notification while delivering Mass Notification messages to ensure they are intelligible.

F. Base-Wide Control

1. If a base-wide control system for mass notification exists on the base, the autonomous control unit shall communicate with the central control unit of the base-wide system. The autonomous control unit shall receive commands/messages from the central control unit and provide status information.

2.6 OVERVOLTAGE AND SURGE PROTECTION

A. Signaling Line Circuit Surge Protection

1. For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62.41.1 and IEEE C62.41.2. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveform(s):
 - a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
 - b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each wireline circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection.

B. Sensor Wiring Surge Protection

1. Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms:
 - a. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
 - b. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.7 ADDRESSABLE INTERFACE DEVICES

- A. The initiating device being monitored shall be configured as a Style B 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 such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation, etc. The module shall be UL or FM 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. Existing fire alarm system initiating device circuits shall be connected to a single module to power and supervise the circuit.

2.8 ADDRESSABLE CONTROL MODULE

- A. 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 or initiate elevator fire service. The module shall be UL or FM 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 module 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. Control Modules shall be located in environmental areas that reflect the conditions to which they were listed.

2.9 SMOKE SENSORS

- A. Photoelectric Smoke Sensors
 1. Provide addressable photoelectric smoke sensors as follows:
 - a. Provide analog/addressable photoelectric smoke sensors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke sensors shall be listed for use with the fire alarm control panel.
 - b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL listed as smoke-automatic fire sensors.
 - c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.
 - d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.
 - e. The sensor address shall identify the particular unit, its location within the system, and its sensitivity setting. Sensors shall be of the low voltage type rated for use on a 24 VDC system.

- f. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device.
 - Primary status
 - Device type
 - Present average value
 - Present sensitivity selected
 - Sensor range (normal, dirty, etc.)

B. Ionization Type Smoke Sensors

1. Provide addressable ionization type smoke sensors as follows:
 - a. Provide analog smoke sensors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion. Smoke sensors shall be listed for use with the fire alarm control panel.
 - b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL or FM listed as smoke-automatic fire sensors.
 - c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.
 - d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.
 - e. The sensor address shall identify the particular unit, its location within the system, and its sensitivity setting. Sensors shall be of the low voltage type rated for use on a 24 VDC system.
 - f. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device.
 - Primary status
 - Device type
 - Present average value
 - Present sensitivity selected
 - Sensor range (normal, dirty, etc.)
 - Sensitivity adjustments for smoke detectors.

C. Duct Smoke Sensors

1. 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 4000fpm. Detectors shall be powered from the fire alarm panel.

- a. 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.
- b. 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.
- c. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS. Auxiliary contacts provide for this function shall be located within 3 feet of the controlled circuit or appliance. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

D. Smoke Sensor Testing

1. Smoke sensors shall be tested in accordance with NFPA 72 and manufacturer's recommended calibrated test method. Submit smoke sensor testing procedures for approval.

2.10 THERMAL SENSORS

A. Heat Detectors

1. Heat detectors shall be designed for detection of fire by combination fixed temperature and rate-of-rise principle. The alarm condition shall be determined by comparing sensor valve with the stored values. Heat detector spacing shall be rated in accordance with UL 521.
2. Combination Fixed-Temperature and Rate-of-Rise Detectors
 - a. Detectors shall be designed for surface or semi-flush outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication that is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F or as shown. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 feet.

B. Self-Test Routines

1. Automatic self-test routines shall be performed on each sensor that will functionally check sensor sensitivity electronics and ensure the accuracy of the value being transmitted. Any sensor that fails this test shall indicate a trouble condition with the sensor location at the control panel.

C. Operator Access

1. An operator at the control panel, having the proper access level, shall have the capability to manually access the following information for each heat sensor:
 - a. Primary status
 - b. Device type
 - c. Present average value
 - d. Sensor range

D. Operator Control

1. An operator at the control panel, having the proper access level, shall have the capability to manually control the following information for each heat sensor:

- a. Alarm detection sensitivity values
- b. Enable or disable the point/device
- c. Control sensors relay driver output

2.11 ELECTRIC POWER

A. Primary Power

1. Power shall be 120 VAC service for the FACP from the normalemergency AC service to the building.

B. Generator

1. Where any emergency generator provides a standby power supply for life safety system circuits, provide a connection from one of the circuits for the fire alarm system. When a generator buss circuit is available for the fire alarm, mass notification, and life safety equipment, then the fire alarm control unit shall monitor the generator with the following supervisory signals:
 - a. Generator Selector Switch in a position other than automatic start
 - b. Generator Running
 - c. Low Fuel
 - d. Failure to Start
 - e. Abnormal conditions such as low oil, high temperature, and low coolant.
 - f. Low Battery
 - g. Emergency transfer in proper mode while generator running

2.12 EMERGENCY POWER SUPPLY

- ### A. Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

B. Batteries

1. Provide sealed, maintenance-free, gel cell batteries as the source for emergency power to the FACP. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.
2. Capacity
 - a. Provide the batteries with sufficient capacity to operate the system under supervisory and trouble conditions, including audible trouble signal devices for 48hours and audible and visual signal devices under alarm conditions for an additional 15minutes.
3. Battery Power Calculations
 - a. Verify that battery capacity exceeds supervisory and alarm power requirements.
 - b. Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Ampere-hour requirements for each system component and each panel component, and the battery-recharging period shall be included.
 - c. Provide complete battery calculations for both the alarm, alert, and supervisory power requirements. Ampere-hour requirements for each system component shall be submitted with the calculations.
 - d. A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries.
 - e. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the

specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

C. Battery Chargers

1. Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 150 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (18 Volts dc), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.13 FIRE ALARM AND MASS NOTIFICATION CONTROL PANEL (FACP/FMCP)

A. Provide a complete control panel fully enclosed in a lockable steel enclosure as specified herein. Operations required for testing or for normal care and maintenance of the systems shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit enclosures shall match exactly.

1. Each control unit shall provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each panel with supervisory functions for power failure, internal component placement, and operation.
2. Visual indication of alarm, supervisory, or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters, that at least 32 are field changeable. The MNS Control panel shall have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages. Provide conductor integrity monitoring for strobe, display, temporary deactivation of fire alarm audible notification appliances and speaker wiring.
3. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least four pre-recorded messages. Provide the ability to automatically repeat pre-recorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, and initiate/synchronize strobes. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

B. Cabinet

1. Install control panel components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of panels as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Fire Alarm and Mass Notification Control Panel" and shall not be less than one inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

C. Control Modules

1. Provide power and control modules to perform all functions of the FACP. Provide audible signals to indicate any alarm, supervisory, or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and relays, if any, on screw terminals in the FACP. Circuits operating at 24 VDC shall not operate at less than 21.6 volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.

D. Silencing Switches

1. Alarm Silencing Switch: Provide an alarm silencing switch at the FACP that shall silence the audible signal but not affect the visual alarm indicator. This switch shall be overridden upon activation of a subsequent alarm.
2. Supervisory/Trouble Silencing Switch: Provide supervisory and trouble silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervision, or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

E. Non-Interfering

1. Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the FACP after the initiating device or devices have been restored to normal.

F. Voice Notification System

1. The Voice Notification System shall comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements ISO 7240-16, IEC 60268-16, except as specified herein. The system shall be a one-way multi-channel voice notification system incorporating user selectability of a minimum 8 distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Textual audible appliances shall produce a slow whoop tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced. Automatic messages shall be broadcast through speakers. The visual strobes and audible message shall automatically be broadcast on the floor. A live voice message shall override the automatic audible output through use of a microphone input at the control panel.
 - a. When using the microphone, live messages shall be broadcast through speakers throughout floor. The system shall be capable of operating all speakers at the same time. The digitalized voice message shall consist of a non-volatile (EPROM) microprocessor based input to the amplifiers. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the slow whoop tone to take over all functions assigned to the failed unit.
 - b. The Mass Notification functions shall override the manual or automatic fire alarm notification or Public Address (PA) functions. The system shall have the capability of utilizing a remote microphone station with redundant controls of the notification system control panel. Class "A" Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level (600 ohms), 25, 70.7 or 100 volt output. The audio amplifier outputs shall be not greater than 100 watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. A hand held microphone shall be provided and, upon activation, shall take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC Circuits activation.
 - c. All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Form "C" contacts shall be provided for system alarm and trouble conditions. Circuits shall be provided for operation of auxiliary appliance during trouble conditions. During a Mass Notification event the panel shall not generate nor cause any trouble alarms to be generated with the Fire Alarm system. The Control Panel for the Voice Notification System shall be independent of the Fire alarm system and shall be capable of autonomous operation. The system shall be housed in same panel with the fire alarm system. Mass Notification functions shall take precedence over all other function performed by the Voice Notification System. Messages shall utilize a male or female voice and shall be similar to the following:

- 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)
"May I have your attention, please. May I have your attention, please. A fire has been reported that may affect your floor. Please walk to the nearest exit and evacuate the building." (Provide a 2second pause.) "May I have your attention, please, (repeat the message)."
 - 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)
"Alert! This is the Mass Notification System.
There is an emergency situation.
DO NOT evacuate the building! Stay in your current location!
Stay tuned for further instructions."
(repeat message 2 times)
 - 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)
"Alert, This is the Mass Notification System.
There is a chemical gas emergency.
Turn off all HVAC equipment, seal all doors and windows with wet fabric, Don protective gear.
DO NOT evacuate the building, Act now!
Listen to the MNS system for further instructions".
(repeat message 2 times)
 - 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)
"Alert, this is the Mass Notification System.
There is a explosive blast risk along the South wall of your building.
Quietly move towards the north side of the building, and exit from the north stairs.
Move away from the building heading north to the north parking area.
(repeat message 2 times).
- d. The Remote Microphone station shall incorporate a Push-To-Talk (PTT) microphone, redundant controls and system status indicators of/for the system. The unit shall incorporate microphone override of any tone generation or prerecorded messages. The unit shall be fully supervised from the control panel. The housing shall contain a lock that is keyed identical to the fire alarm system for the building.
- e. Auxiliary Input Module shall be designed to be an outboard expansion module to either expand the number of optional remote microphone stations, or allow a telephone interface.
- f. Remote Microphone station (PA) shall incorporate a Push-To-Talk (PTT) microphone, and controls to allow Public Address paging in the facility. The Public Address paging function shall not override any alarm or notification functions. The microphone shall be handheld style.

G. Memory

1. Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

H. Field Programmability

1. Provide control units and control panels that are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

I. Input/Output Modifications

1. The FACP shall contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel mounted keypad. Any bypass or modification to the system shall indicate a trouble condition on the FACP, and a printed output of the trouble condition.

J. Resetting

1. Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

K. Instructions

1. Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

L. Walk Test

1. The FACP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

M. History Logging

1. In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

N. RS-232-C Output

1. Each local control panel shall be capable of operating remote service type cathode ray tubes (CRTs), printers, and/or modems. The output shall be paralleled ASCII from an EIA RS-232-C connection with a baud rate of 1200 or 2400 to allow use of any commonly available CRT, printer, or modem.

2.14 REMOTE FIRE ALARM CONTROL UNITS

- A. Provide complete remote control units fully enclosed in a lockable steel enclosure as specified herein. Operations required for testing or for normal care and maintenance of the control units shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit enclosures shall match exactly. Each control unit shall provide power, supervision, control, and logic for its portion of the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each unit with supervisory functions for power failure, internal component placement, and operation.

B. Cabinet

1. Install remote control unit components in cabinets large enough to accommodate components and also to allow ample gutter space for interconnection of units as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall be labeled "Remote Fire Alarm Control Unit" and shall not be less than one inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

C. Control Modules

1. Provide power and control modules to perform all functions of the remote control unit. Provide audible signals to indicate any alarm or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and relays, if any, on screw terminals in the remote control unit. Circuits operating at 24 VDC shall not operate at less than 21.6 volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage. Circuits shall be arranged so that there is 25 percent spare capacity for any circuit.

D. Silencing Switches

1. Provide an alarm silencing switch at the remote control unit that shall silence the audible signal but not affect the visual alarm indicator. This switch shall be overridden upon activation of a subsequent alarm. Provide trouble and supervisory silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent trouble or supervisory signal. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

E. Non-Interfering

1. Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually resettable by switch from the remote control unit after the initiating device or devices have been restored to normal.

F. Memory

1. Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

G. Field Programmability

1. Provide control units that are fully field programmable for control, initiating, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

H. Input/Output Modifications

1. Each remote control unit shall contain features that allow the elimination of input devices from the system or the modification of system outputs. Any such modifications shall indicate a trouble condition on the remote control unit, the FACP, and a printed output of the trouble condition.

I. Resetting

1. Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory, or trouble condition on the system still exists.

J. Instructions

1. Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the remote fire alarm control unit. Install the frame in a conspicuous location observable from the remote fire alarm control unit. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

K. Walk Test

1. Each remote control unit shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

L. History Logging

1. In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.15 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

- A. Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a fire alarm control unit, terminal cabinet, or in the fire alarm control panel. The system shall automatically operate and control all building fire alarm speakers. Each amplifier shall be single output channel.

B. Construction

1. Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

C. Inputs

1. Each system shall be equipped with separate inputs from the tone generator, digitalized voice driver and panel mounted microphone. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.

D. Tone Generator

1. The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a slow whoop tone, that shall slowly ascend from low (500 hertz) to high (1200 hertz), and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. Each slow whoop cycle shall last approximately 4 seconds. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

E. Protection Circuits

1. Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified.

2.16 GRAPHIC ANNUNCIATOR

A. Annunciator Panel

1. Provide a graphic annunciator that indicates the building floor plan. Alarm circuit boundaries shall be clearly marked on the floor plan. Annunciator shall include a north arrow, location of the fire alarm control panel, and a "you are here" indicator. The graphic annunciator shall be a minimum size of 3 by 3 feet.

B. Indicating Lights

1. Provide the graphic annunciator with individual light emitting diode (LED) indicating lights for each type of alarm and supervisory device. Provide an amber LED for indicating a system trouble

condition and a separate amber LED for indicating a supervisory condition. Provide a green LED to indicate presence of power and a red LED to indicate an alarm condition. The actuation of any alarm signal shall cause the illumination of a boundary LED, a floor LED, and a device LED. System supervisory or trouble shall cause the illumination of a trouble LED. In addition to all of these LED indicators, provide normal power and emergency power indicating LEDs. Provide a push button LED test switch. The test switch shall not require key operation. Annunciator LEDs shall only be extinguished by operation of the system reset switch on the FACP.

C. Material

1. Construct the graphic annunciator face plate of smoked Plexiglas. The face plate shall be backlit with LEDs. Control equipment and wiring shall be housed in a recessed back box. The exposed portions of the back box shall be bronze anodize with knockouts.

D. Programming

1. Where programming for the operation of the proper LEDs is accomplished by a separate software program than the software for the FACP, the software program shall not require reprogramming after loss of power. The software shall be reprogrammable in the field.

2.17 SYSTEM PRINTERS

1. Provide a system printer to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout shall be by circuit, device, and function as provided in the FACP. Printer shall operate on a 120 VAC, 60 Hz power supply. The printer shall have at least 40 characters per line and have a 96 ASCII character set. The printer shall have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second. Printer shall not contain internal software that is essential for proper operation.
2. When the FACP receives a signal, the alarm, supervisory, and trouble condition shall be printed. The printout shall include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer shall differentiate alarm signals from other printed indications. When the system is reset, this condition shall also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system shall have a buffer to retain the data and it shall be printed when the printer is restored to service. The printer shall have an indicator to alert the operator that the paper has run out.

2.18 FIREFIGHTER TELEPHONE COMMUNICATION SYSTEM

A. Provide a firefighter telephone system as follows:

1. Provide a firefighter telephone communication system with complete, common talk, closed circuits. The system shall include, but not be limited to, a master control station mounted in the fire alarm control panel, a power supply and standby battery system, and remote telephone stations.
2. Provide a master control station that shall provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone hand set from its cradle shall cause both a visual and audible signal to annunciate at the master control station. Removing the hand set at the master control station and depressing a button at the remote telephone hand set shall cause the automatic silencing of the audible signal. Communication between the master control station hand set and any/or all remote hand sets shall require the depressing of a push-to-talk switch located on any/all remote hand sets. During the time that the master control hand set is removed from its cradle it shall be possible to communicate between five remote hand sets and the master control station. Hand sets shall be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It shall not be possible to communicate between two or more remote hand sets with the master control station hand set in its cradle. The master control station hand set shall be red in color and equipped with a 5-foot long strain-relieved coiled cord. Wiring connections shall be made to terminal strips. The master control station shall monitor wire and connections for any opens, shorts, or grounds that would render the system inoperable or unintelligible. The master control station shall be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and shall be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the amber LED

shall be extinguished and the silencing switch shall sound again until the switch is restored to its original position. The master control station shall be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs shall provide for the annunciation of operating and supervisory power. The loss of operating or supervisory power shall cause an audible and visual indication at the master control station and shall also cause the fire alarm trouble signal to sound on the FACP. Switches, LEDs, and controls shall be fully labeled.

3. Provide flush mounted remote telephone stations. Each station shall be equipped with a hinged door that is magnetically locked. Each hand set shall be permanently wired in place with a coiled cord. Each hand set shall be red high-impact cyclac and shall be equipped with a push-to-talk switch that, when operated, shall signal the master control station and a switch-equipped, storage cradle.
4. Provide operating and supervising power from the same supply circuit(s) utilized for the fire alarm control panel.

2.19 MANUAL STATIONS

- A. Provide metal or plastic, semi-flush mounted, single action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire-engine red with molded raised lettering operating instructions of contrasting color. The use of a key or wrench shall be required to reset the station. Manual stations shall be mounted as shown on drawings. Stations shall have a separate screw terminal for each conductor.

2.20 NOTIFICATION APPLIANCES

A. Fire Alarm/Mass Notification Speakers

1. Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. 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.
 - a. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 100 Vac, 70 Vac, 7 Vac, and 25 Vac, by means of selectable tap settings. Tap settings shall include taps of 1/4, 1/2, 1, 2, and 8 watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400Hz to 4000Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 4 inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall mounted unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the Fire Alarm Control Panel/Voice Notification System.
 - b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

B. Visual Notification Appliances

1. Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Americans With Disabilities Act (ADA). Colored lens such as amber, the notifications appliances shall comply with UL 1638. The manufacturer shall have the color lens tests to the full UL 1971 polar plotting criteria, voltage drop, and temperature rise as stated in 1971. Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light and be marked "Fire"~~"Alert"~~ in red letters. Mass Notification Appliances shall have amber high intensity optic lens, xenon flash tubes, and output white light and be marked "ALERT" in red letters. The light pattern shall be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 75 candela (actual output after derating for tinted lens) based on the UL

1971 test. Strobe shall be surface or semi-flush mounted. Where more than two appliances are located in the same room or corridor, provide synchronized operation.

C. Fire Alarm Horns

1. Provide surface in nonfinished areas and in finished areas provide semi-flush mounted electronic multi-tone horns that produce a minimum of four distinct sounds, suitable for use in an electrically supervised circuit. Horns shall have a rating of 90 dBA at 10 feet when tested in accordance with UL 464 while emitting a slow whoop tone. Output from the horn shall be the slow whoop tone. Where horns and strobes are provided in the same location, they may be combined into a single unit. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

D. Connections

1. Provide screw terminals for each notification appliance. Terminals shall be designed to accept the size conductors used in this project without modification.

2.21 ENVIRONMENTAL ENCLOSURES OR GUARDS

- A. Environmental enclosures shall be provided to permit Fire Alarm or Mass Notification components to be used in areas that exceed the environmental limits of the listing. The enclosure shall be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the UL category that the component is currently listed. Guards required to deter mechanical damage shall be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

2.22 VALVE MONITOR SWITCHES (TAMPER SWITCHES)

- A. Provide a tamper switch for each fire protection system control valve. Tamper switches shall be UL listed as "Extinguishing System Attachment" for the location and type of valve supervised. The device shall contain double pole, double throw contacts. Operation of the switch shall cause a supervisory signal to be transmitted to the FACP upon not more than two complete turns of the valve wheel or a closure of 10 percent, whichever is less. Tamper switches shall be equipped with screw terminals for each conductor. Monitor switch with addressable module.

2.23 WATERFLOW DETECTORS

1. Provide vane type waterflow detectors for wet pipe sprinkler systems. The device shall contain double pole, double throw contacts. Equip the detector with a pneumatic time delay, field adjustable from 0 to 90 seconds. The time delay shall be set initially to 30 seconds. The device shall be a UL listed extinguishing system attachment rated for the particular pressure and location that it is installed. Flow switches shall be equipped with screw terminals for each conductor. Monitor switch with addressable module.
2. Provide pressure type waterflow detectors for dry pipe sprinkler systems, pre-action, and deluge systems. Switch shall be equipped with a time delay from 0 to 90 seconds. The device shall contain double pole, double throw contacts. The device shall be a UL listed extinguishing system attachment rated for the particular pressure and location that it is installed. Switch shall be equipped with screw terminals for each conductor. Monitor switch with addressable module.

2.24 INTERFACE TO THE BASE WIDE MASS NOTIFICATION NETWORK

A. Radio

1. The radio transceiver shall be bi-directional and meet all the requirements of paragraph, RADIO TRANSMITTER AND INTERFACE PANELS as specified in this Specification Section. The transceiver utilized in the Mass Notification System shall be capable of the following:
 - a. Communication with the existing Monaco Central Control/Monitoring System to provide supervision of communication link and status changes are reported by automatic and manual poll/reply/acknowledge routines.

- b. All monitored points/status changes are transmitted immediately and at programmed intervals until acknowledged by the Central Control/Monitoring System.
 - c. Each transceiver shall transmit a unique identity code as part of all messages; the code is set by the user at the transceiver.
2. Radio Frequency Communications
 - a. Use of radio frequency-type communications systems shall comply with National Telecommunications and Information Administration (NTIA) requirements.
 3. Licensed Radio Frequency Systems
 - a. An approved DD Form 1494 for the system is required prior to operation.

2.25 AUTOMATIC FIRE TRANSMITTERS

A. Radio Transmitter and Interface Panels

1. Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is Monaco and the transceiver shall be fully compatible with this equipment. At the contractor's option, and if UL or FM listed, the transmitter may be housed in the same panel as the fire alarm control panel. The transmitter shall be Narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.
 - a. Operation: Each transmitter shall operate from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic.
 - b. Battery Power: Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.
 - c. Transmitter housing shall be NEMA Type 1. The housing shall contain a lock that is keyed identical to radio alarm transmitter housings on the base. Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.
 - d. Antenna shall be omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 161 km/h. 100 mph. Antennas shall not be mounted to any portion of the building roofing system. Protect the antenna from physical damage.

B. Signals to Be Transmitted to the Base Receiving Station

1. The following signals shall be sent to the base receiving station:
 - a. Sprinkler water flow
 - b. Manual pull stations
 - c. Smoke detectors
 - d. Duct smoke detectors
 - e. Heat detectors

f. Sprinkler valve supervision

2.26 WIRING

- A. Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.
 - B. Alarm Wiring
- 3 The SLC wiring shall be coppercable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. 16 AWG size conductors at a minimum. Notification appliance circuit conductors, that contain audible alarm devices, other than speakers, shall be solid copper No. 14 AWG size conductors at a minimum. Speaker circuits shall be copper No. 16 AWG size conductors at a minimum. Firefighter telephone circuits shall be No. 16 AWG size conductors as a minimum. Wire size shall be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC shall not operate at less than 21.6 volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage. Power wiring, operating at 120 VAC minimum, shall be a minimum No. 12 AWG solid copper having similar insulation.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRE ALARM INITIATING AND INDICATING DEVICES

- a. FACP/FMCP: Locate the FACP/FMCP where indicated on the drawings. Semi-recess or Surface mount the enclosure with the top of the cabinet 6 feet above the finished floor. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FACP.
- b. Manual Stations: Locate manual stations as required by NFPA 101IEC 60268, Part 16, and ASA S3.2 and NFPA 72. Mount stations as shown on drawings..
- c. Notification Appliance Devices: Locate notification appliance devices as required by NFPA 72. Mount assemblies on walls as shown on Drawings.
- d. Smoke and Heat Sensors: Locate sensors as required by NFPA 72 and their listings on a 4 inch mounting box. Sensors located on the ceiling shall be installed not less than 4 inches from a side wall to the near edge. Those located on the wall shall have the top of the sensor at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. In raised floor spaces, the smoke sensors shall be installed to protect 225 square feet per sensor. Install smoke sensors no closer than 5 feet from air handling supply outlets.
- e. Graphic Annunciator: Locate the graphic annunciator as shown on the drawings. Surface mount the panel, with the top of the panel 6 feet above the finished floor.
- f. Water Flow Detectors and Tamper Switches: Locate water flow detectors and tamper switches at each supervised sprinkler valve station.
- g. Firefighter Telephones: Locate wall mounted at lobby.
- h. The modification of any fire alarm system and the procedures shall comply with the requirements of NFPA 241.

3.2 SYSTEM FIELD WIRING

A. Wiring within Cabinets, Enclosures, and Boxes

1. Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make connections with approved pressure type terminal blocks, that are securely mounted. The use of wire nuts or similar devices shall be prohibited. Wiring shall conform to NFPA 70.

B. Alarm Wiring

1. Provide all wiring in rigid metal conduit or intermediate metal conduit. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Electrical metallic tubing conduit is acceptable in dry locations not enclosed in concrete or where not subject to mechanical damage. Conceal conduit in finished areas of new construction and wherever practicable in existing construction. The use of flexible conduit not exceeding a 6 foot length shall be permitted in initiating device circuits. Run conduit or tubing concealed unless specifically shown otherwise on the drawings. Shielded wiring shall be utilized where recommended by the manufacturer. For shielded wiring, the shield shall be grounded at only one point, that shall be in or adjacent to the FACP. Pigtail or T-tap connections to signal line circuits, 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. Color coding is required for circuits and shall be maintained throughout the circuit. Conductors used for the same functions shall be similarly color coded. Wiring shall conform to NFPA 70.

C. Conductor Terminations

1. Labeling of conductors at terminal blocks in terminal cabinets, FACP, and remote fire alarm control units shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FACP, and fire alarm control unit shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.3 FIRESTOPPING

1. Provide firestopping for holes at conduit penetrations through floor slabs, fire rated walls, partitions with fire rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.4 PAINTING

- A. Paint exposed electrical, fire alarm conduit, and surface metal raceway to match adjacent finishes in exposed areas. Paint junction boxes conduit red in unfinished areas. Painting shall comply with Section 09 90 00 PAINTS AND COATINGS.

3.5 FIELD QUALITY CONTROL

A. Testing Procedures

1. Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician, and signed by representative of the installing company, for the fire detection and alarm system 60 days prior to performing system tests. Detailed test procedures shall list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, Guard's Tour equipment, and transient (surge) suppressors. Test procedures shall include sequence of testing, time estimate for each test, and sample test data forms. The test data forms shall be in a check-off format (pass/fail with space to add applicable test data) and shall be used for the preliminary testing and the acceptance testing. The test data forms shall record the test results and shall:
 - a. Identify the NFPA Class and Style of all Initiating Device Circuits (IDC), Notification Appliance Circuits (NAC), Voice Notification System, and Signaling Line Circuits (SLC).
 - b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how this test shall be performed.
 - c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.
 - d. Identify all test equipment and personnel required to perform each test (including equipment necessary for testing smoke detectors using real smoke).
 - e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

B. Tests Stages

- a. Preliminary Testing: Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

- b. Request for Formal Inspection and Tests: When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contracting Offices Designated Representative (COR).
- c. Final Testing: Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. Furnish instruments and personnel required for the tests. A final acceptance test will not be scheduled until the operation and maintenance (O&M) manuals are furnished to the Contracting Officer and the following are provided at the job site:
 - The systems manufacturer's technical representative
 - Marked-up red line drawings of the system as actually installed
 - Megger test results
 - Loop resistance test results
 - Complete program printout including input/output addresses
 - The final tests shall be witnessed by the Contracting Offices Designated Representative (COR). At this time, any and all required tests shall be repeated at their discretion. Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to the Contracting Officer for review and acceptance.

C. Minimum System Tests

1. Test the system in accordance with the procedures outlined in NFPA 72, ISO 7240-16, IEC 60268-16. The required tests are as follows:
 - a. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
 - b. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
 - c. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.
 - d. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
 - e. Test each initiating and indicating device and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72.
 - f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.
 - g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.
 - h. Determine that the system is operable under trouble conditions as specified.

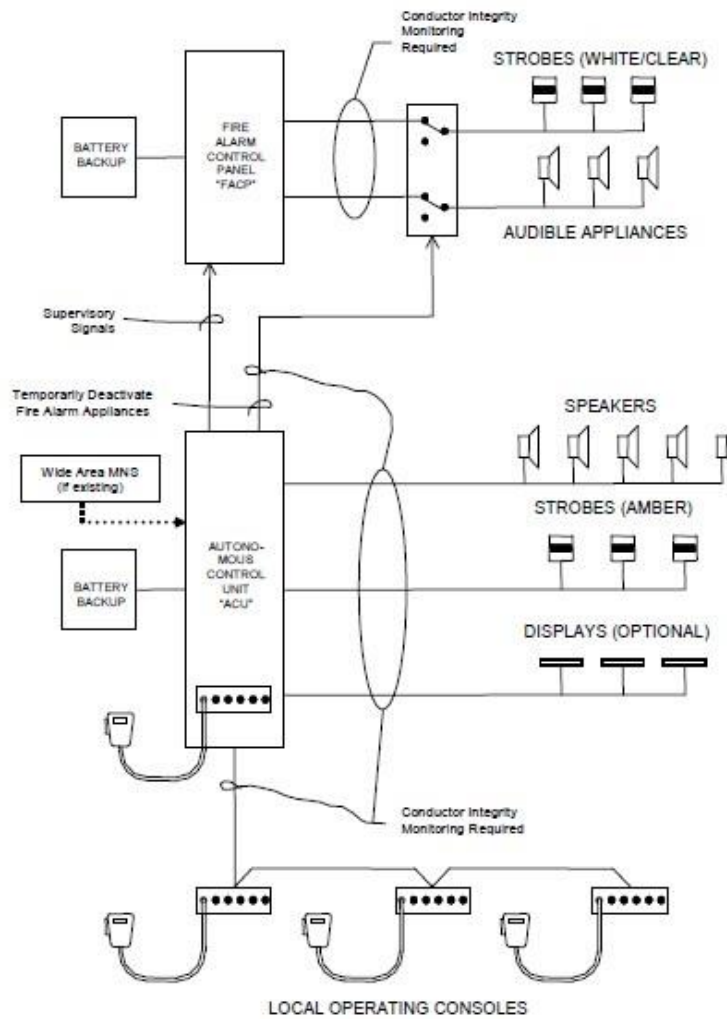
- i. Visually inspect wiring.
- j. Test the battery charger and batteries.
- k. Verify that software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided to the Contracting Officer.
- l. Verify that red-line drawings are accurate.
- m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.
- n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.
- o. Disconnect the verification feature for smoke sensors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke sensors shall be conducted using real smoke. The use of canned smoke is prohibited.
- p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.
- q. Audibility Intelligibility testing of the Voice Evacuation Notification System shall be accomplished iaw NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2.
- r. Opening the circuit at not less than 25% alarm initiating devices and notification appliances to test the wiring supervisory feature.
- s. Demonstrate modem communications with remote sites as specified by the COR. Dial in capability shall also, be demonstrated, using specified security.
- t. Demonstrate fiber optic communications with remote sites as specified by the COR. Dial in capability shall also, be demonstrated, using specified security.

3.6 INSTRUCTION OF GOVERNMENT EMPLOYEES

- A. Equipment manufacturer shall provide 1 day on site and 5 days of technical training to the Government at the manufacturing facility. Training shall allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises. Room and board costs shall be included for two Government personnel. Factory training shall occur within 6 months of system acceptance.
- B. Instructor
 1. Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm and fire detection system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work.
- C. Required Instruction Time
 1. Provide 8 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.
- D. Technical Data and Computer Software
 1. Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize designated government personnel with proper operation of the installed system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

END OF SECTION 283176

Figure 5-2. Individual Building Mass Notification System:
Separate Fire Alarm System and MNS
(Army and Air Force)



SECTION 310000 - EARTHWORK

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
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B. AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances
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C. ASTM INTERNATIONAL (ASTM)

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
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ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
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ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing
------------	--

ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
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ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
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ASTM D1883	(2016) Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
------------	--

ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
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ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
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ASTM D4718/D4718M	(2015) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
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ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
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D. U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1
(2014) Safety and Health Requirements Manual

1.2 DEFINITIONS

- A. Satisfactory Materials: Satisfactory materials comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP. Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements and railroads which comprise stones less than 3 inches in any dimension.
- B. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.
- C. Cohesionless and Cohesive Materials: Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C136/C136M and ASTM D1140.
- D. Degree of Compaction: Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with ASTM D4718/D4718M. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.
- E. Hard/Unyielding Materials: Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 24 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.
- F. Rock: Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.
- G. Unstable Material: Unstable materials are too wet to properly support the utility pipe, conduit, or appurtenant structure.
- H. Select Granular Material
 - 1. General Requirements: Select granular material consist of materials classified as GW, GP, SW, SP, by ASTM D2487 where indicated. The liquid limit of such material must not exceed 35percent when tested in accordance with ASTM D4318. The plasticity index must not be greater than 12 percent when tested in accordance with ASTM D4318, and not more than 35 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D1140.
 - 2. California Bearing Ratio Values: Bearing Ratio: At 0.1 inch penetration, provide a bearing ratio per the Geotechnical Report at 95 percent ASTM D1557 maximum density as determined in accordance with ASTM D1883 for a laboratory soaking period of not less than 4 days.

Conform the combined material to the following sieve analysis:

Sieve Size	Percent Passing by Weight
2-1/2 inches	100
No. 4	40 - 85
No. 10	20 - 80

Sieve Size	Percent Passing by Weight
No. 40	10 - 60
No. 200	5 - 25

- I. Initial Backfill Material: Initial backfill consists of select granular material or satisfactory materials free from rocks 1 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than 3/4 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.
- J. Expansive Soils: Expansive soils are defined as soils that have a plasticity index equal to or greater than 20 when tested in accordance with ASTM D4318.

1.3 SYSTEM DESCRIPTION

Subsurface soil boring logs are shown on the drawings. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

- A. Classification of Excavation: No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.
 - 1. Common Excavation: Include common excavation with the satisfactory removal and disposal of all materials not classified as rock excavation.
 - 2. Rock Excavation: Submit notification of encountering rock in the project. Include rock excavation with blasting, excavating, grading, disposing of material classified as rock, and the satisfactory removal and disposal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). Include the removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic yard in volume that may be encountered in the work in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, uncover such material and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.
- B. Dewatering Work Plan: Submit procedures for accomplishing dewatering work.

1.4 ACTION SUBMITTALS

- A. SD-01 Preconstruction Submittals
 - 1. Shoring

2. Dewatering Work Plan

1.5 INFORMATION SUBMITTALS

- A. SD-03 Product Data
 - 1. Utilization of Excavated Materials
- B. SD-06 Test Reports
 - 1. Testing
 - 2. Within 24 hours of conclusion of physical tests, submit 3 copies of test results, including calibration curves and results of calibration tests.
- C. SD-07 Certificates
 - 1. Testing

PART 2 - PRODUCTS

2.1 BURIED WARNING AND IDENTIFICATION TAPE

Provide metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications
Blue	Water Systems
Green	Sewer Systems
White	Steam Systems
Gray	Compressed Air

- A. Warning Tape for Metallic Piping: Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.
- B. Detectable Warning Tape for Non-Metallic Piping: Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.2 DETECTION WIRE FOR NON-METALLIC PIPING

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

PART 3 EXECUTION

3.1 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill and

unsatisfactory excavated material as specified in paragraph DISPOSITION OF SURPLUS MATERIAL. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

- A. Drainage Structures: Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.
- B. Drainage: Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.
- C. Dewatering: Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do not permit French drains, sumps, ditches or trenches within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. While the excavation is open, maintain the water level continuously, at least 0.5 feet below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly.
- D. Trench Excavation Requirements: Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended in the manufacturer's printed installation manual. Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in, as determined by the Contractor's Safety Engineer or other competent person; refer to USACE publication EM 385-1-1. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.
 - 1. Bottom Preparation: Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 2 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.
 - 2. Removal of Unyielding Material: Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, remove such material 6 inch below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.
 - 3. Removal of Unstable Material: Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is

responsible for excavating the resulting material and replacing it without additional cost to the Government.

4. Excavation for Appurtenances: Provide excavation for manholes, catch-basins, inlets, or similar structures of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. Specify removal of unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.
 5. Jacking, Boring, and Tunneling: Unless otherwise indicated, provide excavation by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.
- E. Underground Utilities: The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.
- F. Structural Excavation: Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

3.2 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

Notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit or borrow areas to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Provide neatly trimmed and drained borrow pits after the excavation is completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.3 SHORING

- A. General Requirements: Submit a Shoring and Sheet piling plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheet piling as excavations are backfilled, in a manner to prevent caving.
- B. Geotechnical Engineer: Hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.4 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory and unsatisfactory as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.5 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or water flow.

3.6 GROUND SURFACE PREPARATION

- A. General Requirements: Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.
- B. Frozen Material: Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.7 UTILIZATION OF EXCAVATED MATERIALS

Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Submit procedure and location for disposal of unused satisfactory material. Dispose surplus satisfactory excavated material not required for fill and unsatisfactory excavated material as specified in paragraph DISPOSITION OF SURPLUS MATERIAL. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.8 BURIED TAPE AND DETECTION WIRE

- A. Buried Warning and Identification Tape: Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.
- B. Buried Detection Wire: Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over its entire length. Install wires at manholes between the top of the corbel and the frame and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.9 FILLING, BACKFILLING AND COMPACTION

Place fill and backfill beneath and adjacent to any and all type of structures, in successive horizontal layers of loose material not more than 8 inches in depth, or in loose layers not more than 5 inches in depth when using hand-operated compaction equipment. Compact to at least 95 percent of laboratory maximum density for both cohesive and cohesionless materials, except as otherwise specified. Perform compaction in such a manner as to prevent wedging action or eccentric loading upon or against the structure. Moisture condition fill and backfill material to a moisture content that will readily facilitate obtaining the specified compaction.

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

- A. Trench Backfill: Backfill trenches to the grade shown on Construction Plans.
 - 1. Replacement of Unyielding Material: Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material.

2. Replacement of Unstable Material: Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6 inches loose thickness.
3. Bedding and Initial Backfill: Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Compact backfill to top of pipe to 95 percent of ASTM D698 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:
 - a. Class I: Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.
 - b. Class II: Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.
 - c. Gravel and Crushed Stone: Clean, coarsely graded natural gravel, crushed stone or a combination thereof having a classification of GW in accordance with ASTM D2487 for bedding. Do not exceed maximum particle size of 3 inches.
4. Final Backfill: Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:
 - a. Roadways, Railroads, and Airfields: Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.
 - b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Deposit backfill in layers of a maximum of 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.10 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

- A. Gas Distribution: Excavate trenches to a depth that will provide a minimum 18 inches of cover in rock excavation and a minimum 24 inch of cover in other excavation.
- B. Water Lines: Excavate trenches to a depth that provides a minimum cover of 4 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.
- C. Heat Distribution System: Free initial backfill material of stones larger than 1/4 inch in any dimension.
- D. Electrical Distribution System: Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.11 SUBGRADE PREPARATION

- A. Construction: Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inches below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.
- B. Compaction: Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least 90 percent of laboratory maximum density.

1. Subgrade for Pavements: Compact subgrade for pavements to at least 90 percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 6 inch of subgrade.

3.12 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

- A. Subgrade and Embankments: During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.
- B. Capillary Water Barrier: Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.
- C. Grading Around Structures: Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.13 TESTING

- A. Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. Submit qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer.
 1. Determine field in-place density in accordance with ASTM D6938. When ASTM D6938 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D1556/D1556M. ASTM D6938 results in a wet unit weight of soil in determining the moisture content of the soil when using this method.
 2. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements.
 3. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.
- B. Fill and Backfill Material Gradation: One test per 500 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C136/C136M.
- C. In-Place Densities

1. One test per 2500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.
 2. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.
 3. One test per 100 linear feet, or fraction thereof, of each lift of embankment or backfill for roads.
- D. Moisture Contents: In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.
- E. Optimum Moisture and Laboratory Maximum Density: Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.
- F. Tolerance Tests for Subgrades: Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.
- G. Displacement of Sewers: After other required tests have been performed and the trench backfill compacted to 2 feet above the top of the pipe, inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the Contracting Officer. Inspect pipe sizes larger than 36 inches, while inspecting smaller diameter pipe by shining a light between manholes or manhole locations. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.14 DISPOSITION OF SURPLUS MATERIAL

Surplus material and excavated unsatisfactory material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber shall be removed from Government property and properly disposed of in accordance with all applicable laws and regulations.

END OF SECTION 310000

- C. Qualifications: For the application of pesticides, use the services of a subcontractor whose principal business is pest control. The subcontractor shall be licensed and certified in the state where the work is to be performed. Termiticide applicators shall also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control.

1.5 FIELD CONDITIONS

- A. Soil Treatment:
 - 1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
 - 2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (*Coptotermes formosanus*). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [BASF Corp. - Construction Chemicals](#).
 - b. [Bayer Environmental Science](#).
 - c. [Ensystem, Inc.](#)
 - d. [Syngenta](#).
 - 2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

2.3 STORAGE

Store materials in designated areas and in accordance with manufacturer's labels. Termiticides and related materials shall be kept under lock and key when unattended.

2.4 HANDLING

Observe manufacturer's warnings and precautions. Termiticides shall be handled in accordance with manufacturer's labels, preventing contamination by dirt, water, and organic material. Protect termiticides from sunlight as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 - 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

C. SITE CONDITIONS

The following conditions will determine the time of application.

- 1. Runoff and Wind Drift: Do not apply termiticide during or immediately following heavy rains. Applications shall not be performed when conditions may cause runoff or create an environmental hazard. Applications shall not be performed when average wind speed exceeds 10 miles per hour. The termiticide shall not be allowed to enter water systems, aquifers, or endanger humans or animals.
 - a. Vapor Barriers and Waterproof Membranes: Termiticide shall be applied prior to placement of a vapor barrier or waterproof membrane.
 - b. Utilities and Vents: Prior to application, HVAC ducts and vents located in treatment area shall be turned off and blocked to protect people and animals from termiticide.
- 2. Placement of Concrete: Place concrete covering treated soils as soon as the termiticide has reached maximum penetration into the soil. Time for maximum penetration shall be as recommended by the manufacturer.

3.3 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.
 - 1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - 2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
 - 3. Masonry: Treat voids.

4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.
- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.
- D. Equipment Calibration and Tank Measurement: Immediately prior to commencement of termiticide application, calibration tests shall be conducted on the application equipment to be used and the application tank shall be measured to determine the volume and contents. These tests shall confirm that the application equipment is operating within the manufacturer's specifications and will meet the specified requirements. Provide written certification of the equipment calibration test results within 1 week of testing.
- E. Mixing and Application: Formulating, mixing, and application shall be performed in the presence of the Contracting Officer or the technical representative. A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying termiticides shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.
- F. Treatment Method: For areas to be treated, establish complete and unbroken vertical and/or horizontal soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Application shall not be made to areas which serve as crawl spaces or for use as a plenum air space.

3.4 PROTECTION

- A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.5 CLEANUP

Once application has been completed, proceed with clean up and protection of the site without delay.

END OF SECTION 313116

SECTION 321613 - CONCRETE SIDEWALKS

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only. Latest Editions

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM C 31	Making and Curing Concrete Test Specimens in the Field
ASTM C 143	Slump of Portland Cement Concrete
ASTM C 171	Sheet Materials for Curing Concrete
ASTM C 172	Sampling Freshly Mixed Concrete
ASTM C 173	Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	Air Content of Freshly Mixed concrete by the Pressure Method
ASTM C 309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D 1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

FEDERAL SPECIFICATIONS (FS)

FS SS-S-1401	Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Asphalt Concrete Pavements
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1.2 INFORMATION SUBMITTALS

The following shall be submitted in accordance with SUBMITTALS SECTION 013300.

Test Reports: Copies of all test reports for tests specified in paragraphs "CONCRETE" and "FIELD QUALITY CONTROL" shall be submitted within 24 hours of the completion of the test.

1.3 WEATHER LIMITATIONS

- A. Placing During Cold Weather: Concrete placement shall be discontinued when the air temperature reaches 40 degrees F and is falling. Placement may begin when the air temperature reaches 40 degrees F and is rising. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 40 degrees F, placement shall be approved in writing. Approval shall be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for

maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

- B. Placing During Warm Weather: The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95 degrees F.

1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

- A. General Requirements: Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.
- B. Straightedge: The Contractor shall furnish and maintain at the jobsite, in good condition one 10-foot straightedge for testing the concrete surface. The straightedge shall be made available for Government use. The straightedge shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, reinforced to insure rigidity and accuracy. Straightedge shall have handles to facilitate movement on the concrete surface.

PART 2 - PRODUCTS

2.1 CONCRETE

Concrete shall conform to the applicable requirements of Section 03301 - CONCRETE FOR BUILDING CONSTRUCTION except as otherwise specified. Concrete shall have a minimum compressive strength of 3000 psi at 28 days.

- A. Air Content: Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.
- B. Slump: The concrete slump shall be 3 inches minimum to 4 1/2 inches maximum where determined in accordance with ASTM C 143.
- C. Reinforcement Steel: Wire mesh reinforcement shall conform to ASTM A1064/A1064M or reinforcement bars conforming to ASTM A615/A615M.

2.2 CONCRETE CURING MATERIALS

- A. White Pigmented Membrane-Forming Curing Compound: White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 JOINT FILLER STRIPS

- A. Expansion Joint Filler, Premolded: Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 1/2-inch thick, unless otherwise indicated.

2.4 JOINT SEALANTS: Provide one of the following.

- A. Joint Sealant, Cold-Applied, ASTM D 1850.
- B. Joint Sealant, Hot-Poured, FS SS-S-1401.

2.5 PLASTIC ZIPPER

- A. GREENSTREAK "Zip-Cap"; size as detailed.

2.6 FORM WORK

Form work shall be designed and constructed to insure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2-inch nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4-inch boards, laminated to the required thickness. Steel forms shall

be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

- A. Sidewalk Forms: Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted as shown.

- A. Maintenance of Subgrade: The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected so as to produce a subgrade free from frost when the concrete is deposited.
- B. Sidewalk Subgrade: Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms. Density testing shall be performed once per 600 square feet.

3.2 FORM SETTING

Forms shall be carefully set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of three stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

- A. Sidewalks: Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10-foot long section. After forms are set, grade and alignment shall be checked with a 10-foot straightedge. Forms shall have a transverse slope of 1/4-inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

- A. Formed Sidewalks: Concrete shall be placed in the forms in one layer of such thickness that when consolidated and finished the sidewalks will be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a wood float, bull float, or darby, edged and broom finished.
- B. Concrete Finishing: After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic.
- C. Edge and Joint Finishing: All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.
- D. Surface and Thickness Tolerances: Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 0.25 inch.

3.4 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Reference drawings for locations.

- A. **Contraction Joints:** The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8-inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started.
- B. **Isolation Joints:** Isolation joints shall be formed with 1/2-inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer. Concrete at the joint shall be surface dry and the atmospheric and pavement temperatures shall be above 50 degrees F at the time of application of joint-sealing materials. Joints shall be filled with sealer flush with the concrete surface in such manner as to minimize spilling on the walk surface. Spilled sealing material shall be removed immediately and the surface of the walk cleaned.
- C. **Reinforcement Steel Placement:** Reinforcement steel shall be accurately and securely fastened in place with suitable ties before the concrete is placed.

3.5 CURING AND PROTECTION

- A. **General Requirements:** Concrete shall be protected against loss of moisture, rapid temperature changes and loading for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.
 - 1. **Membrane Curing Method:** A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.
- B. **Backfilling:** After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

- C. Protection: Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction.

3.6 FIELD QUALITY CONTROL

- A. General Requirements: The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.
- B. Concrete Testing
 - 1. Strength Testing: The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 150 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31 by an approved testing laboratory. Each strength test result shall be the average of two test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.
 - 2. Air Content: Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.
 - 3. Slump Test: Two slump tests shall be made on randomly selected batches of each class of concrete for every 150 cubic yards, or fraction thereof, of concrete placed during each day. Additional tests will be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noticed along the edges of slip-formed concrete.
- C. Surface Evaluation: The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.7 SURFACE DEFICIENCIES AND CORRECTIONS

- A. Thickness Deficiency: When measurements indicate that the completed concrete section is deficient in thickness by more than 0.25 inch the deficient section will be removed, between regularly scheduled joints, and replaced.
- B. High Areas: In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. All pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.
- C. Appearance: Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

3.8 REMOVAL AND REPLACEMENT OF DEFECTIVE CONCRETE

Defective or damaged concrete shall be removed and replaced as specified herein, and a method of curing shall be

employed as directed. All removed concrete shall be replaced with concrete of the thickness and quality required by these specifications. In no case shall the removal and replacement of concrete result in a slab less than the full sidewalk or curb and gutter width or a joint less than 5 feet from a regularly scheduled transverse joint. The defective concrete shall be removed carefully so that the adjacent section is not damaged. When a portion of the unfractured slab is replaced, a full depth saw cut shall be made transversely across the slab in the required location, and the concrete shall be removed to provide a vertical face in the remaining portion of the slab. Prior to placement of the fresh concrete, the face of the slab shall

be cleaned of debris and loose concrete. Transverse joints of the replaced slab or portion thereof shall be constructed as indicated. The joints shall be sealed as specified. Removal and replacement of defective or damaged concrete shall be accomplished by the Contractor at no additional cost to the Government.

END OF SECTION 321613

SECTION 329113 – SOIL PREPARATION

PART 1 - GENERAL

- 1.1 SUMMARY (Not Applicable)
- 1.2 REFERENCES (Not Applicable)
- 1.3 INFORMATION SUBMITTALS

The following shall be submitted in accordance with SECTION 013300:

- A. The Contractor shall furnish a list and description of the equipment that is proposed for handling and placing all topsoil.

1.4 INSPECTION

Adequate amounts of topsoil should be available on the project site.

- A. Offsite topsoil source: Not less than 5 days prior to the commencement of topsoiling operations, the Contracting Officer shall be notified of the offsite sources from which topsoil is to be furnished. The material will be inspected to determine whether the selected topsoil meets the requirements. The topsoil shall be approved prior to use.

PART 2 - PRODUCTS

2.1 TOPSOIL

All topsoil necessary to complete the work shall be obtained from topsoil stockpiles from grading and excavating operations. Topsoil shall be free from tree roots, stones, shale, parent and other materials that hinder grading, planting, plant growth and maintenance operations, and free from noxious and other objectionable weed seeds and toxic substances.

PART 3 - EXECUTION

3.1 GENERAL

Graded areas shall be topsoiled where indicated on plans and where it is determined by the Contracting Officer that at least 4 inches of suitable soil for the growth of grass is not present. Equipment necessary for handling and placing all materials required shall be on hand, in good condition and shall be approved before the work is started. Grades on the areas to be topsoiled are shown on the drawings and shall be maintained in a true and even condition.

3.2 TILLAGE

Immediately prior to dumping and spreading the topsoil, the subgrade shall be double tilled to a depth of 2 inches using a chisel plow with the 1 chisels set not more than 10 inches apart. Tillage shall be accomplished across the slope.

3.3 PLACING TOPSOIL

Topsoil shall be uniformly distributed and evenly spread to an average thickness of 4 inches, with a minimum thickness of 3 inches. Topsoil shall be spread so that planting can proceed with little additional soil preparation or tillage. Surface irregularities resulting from topsoiling or other operations shall be leveled to prevent depressions. The grades shall be adjusted to assure that the planted grade shall be 1- inch below the adjoining grade of any surfaced area. Topsoil shall not

be placed when the subgrade is frozen, excessively wet or compacted, extremely dry, or in a condition detrimental to the proposed planting or grading.

3.4 CLEANUP

Prior to topsoiling, vegetation that may interfere with operations shall be mowed, grubbed, and raked. The collected material shall be removed from the site. The surface shall be cleaned of stumps, and stones larger than 1 inch in diameter, and roots, cable, wire and other materials that might hinder the work or subsequent maintenance shall also be removed.

END OF SECTION 329113

SECTION 329230 - SEEDING

PART 1.0 - GENERAL

- 1.1 After completion of the topsoiling operation, all bare topsoil within the limits of construction shall receive hydroseed treatment for the rapid establishment of turf. The Contractor shall furnish all labor, tools, materials and equipment necessary to provide and install hydroseed as specified.

Hydroseeding work shall be accomplished only when satisfactory results can be expected. When conditions such as drought, excessive moisture, high winds, or other factors prevail to such an extent that satisfactory results are not likely to be obtained, the Contracting Officer or designated representative may, at his own discretion, stop any phase of the work. The work shall be resumed only when, in the opinion of the Contracting Officer, the desired results are likely to be obtained. Establishment of turf shall be accomplished on all unpaved, graded and disturbed areas that are the result of the Contractor's operations.

The work shall include the application of seed, fertilizer, mulch, water, and all other operations necessary to provide the growth specified herein.

PART 2.0 - PRODUCTS

- 2.1 Materials used in the hydroseeding operation shall be of the best quality available. The hydromulch shall consist of the following:

- A. Grass - applied from May 1 to October 15.

Conwed - 2000 Wood Cellulose Fiber
Hulled Bermuda Grass Seed
8-8-8 Fertilizer

The mixture shall be applied at the following rates:

50 lb. Conwed	per 1000 square feet
2 lb. Bermuda Grass Seed	per 1000 square feet
7 gal. Liquid Fertilizer	per 5000 square feet, or
70 lb. granular Fertilizer	per 5000 square feet

- 2.2 Any deviation from the above rates and application seasons shall be approved by the Contracting Officer.

Hydroseed shall be furnished and placed free of noxious weeds and undesirable plants, stones, roots of trees and other materials that hinder development and maintenance.

Water shall be free from oil, acid, alkali, salt and other substances harmful to growth of grass and shall be from a source approved prior to use.

PART 3 - EXECUTION

- 3.1 After topsoil has been placed, hydroseeding shall be performed in accordance with standard practices, as approved by the Contracting Officer. All areas to receive hydroseeding shall be cultivated to a depth of at least one inch (1"). The cross section previously established shall be maintained throughout the process of cultivation and any necessary reshaping shall be done prior to hydroseeding. Clean water will be provided by the Government and will be available at the site.

PART 4 - MAINTENANCE

- 4.1 It shall be the responsibility of the Contractor to maintain the planted areas during the planting period and for an additional period of not less than 90 calendar days. Maintenance work shall be accomplished until an acceptable stand of grass is present. Maintenance shall consist of watering, replanting, mowing, maintaining existing grades and repair of erosion damage. Areas on which an acceptable stand of grass is not present at the end of the 90 day period shall be hydroseeded again, or maintained by the Contractor until an acceptable stand of grass is present at no additional cost to the Government.

- A. Watering: The Contractor shall be responsible for applying water at sufficient quantity and frequency to establish an acceptable stand of grass within the maintenance period.
- B. Replanting: Areas on which a stand of growing grass is not present in a reasonable length of time, it shall be hydroseeded again in accordance with the appropriate planting season and shall continue to be hydroseeded and maintained throughout the maintenance period until an acceptable stand is obtained. A stand shall be defined as live grass plants from hydroseeding occurring over 95% of the area, with no more than 10 square feet left uncovered in any one place.
- C. Mowing: Vegetation shall be kept under control by mowing. Any time that the weed or grass growth reaches a height of 4 inches, the areas shall be mowed. Mowing shall be done with approved mowing machines in such manner that shall leave a vegetation height of between 2 and 2 1/2 inches.
- D. Maintenance of Grades and Repair of Erosion Damage: It shall be the responsibility of the Contractor to maintain the original grades of the lawn areas after the commencement of planting operations and during the specified maintenance period. Any damage to the finished surface from Contractor's operations shall be promptly repaired. In the event erosion occurs from either watering operations or from rainfall, such damage shall be promptly repaired. Ruts, ridges, tracks and other surface irregularities shall be corrected and the areas replanted, where required, prior to acceptance.

END OF SECTION 32930

SECTION 331100 – WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. All publications shall be the latest version/edition/revision of the documents listed below, in effect on the date of this solicitation, except where a date is given.

A. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts

B. AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C213	(2015) Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C500	(2009) Metal-Seated Gate Valves for Water Supply Service
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service
AWWA C515	(2015) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(2017) Protective Interior Coatings for Valves and Hydrants
AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2014) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C655	(2009) Field Dechlorination

AWWA C700	(2015) Cold-Water Meters – Displacement Type, Metal Alloy Main Case
AWWA C701	(2015) Cold-Water Meters - Turbine Type for Customer Service
AWWA C702	(2015) Cold-Water Meters - Compound Type
AWWA C706	(2010) Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C707	(2010; R 2016) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(2014) Underground Service Line Valves and Fittings
AWWA C900	(2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA M6	(2012) Water Meters - Selection, Installation, Testing, and Maintenance
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe
AWWA M23	(2002; 2nd Ed) Manual: PVC Pipe - Design and Installation
AWWA M41	(2009; 3rd Ed) Ductile-Iron Pipe and Fittings
AWWA M55	(2006) PE Pipe - Design and Installation
C. ASTM INTERNATIONAL (ASTM)	
ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM C94/C94M	(2018) Standard Specification for Ready-Mixed Concrete
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

	ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
	ASTM D2467	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
	ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
	ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
	ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
	ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
	ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
D.	MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)	
	MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves
E.	NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
	NFPA 24	(2016; ERTA 2016) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
F.	NSF INTERNATIONAL (NSF)	
	NSF 372	(2016) Drinking Water System Components - Lead Content
	NSF/ANSI 14	(2018) Plastics Piping System Components and Related Materials
	NSF/ANSI 61	(2019) Drinking Water System Components - Health Effects
G.	UNDERWRITERS LABORATORIES (UL)	
	UL 262	(2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service
	UL 312	(2010; Reprint Mar 2018) UL Standard for Safety Check Valves for Fire-Protection Service
1.2	DEFINITIONS	
A.	Water Transmission Mains: Water transmission mains include water piping having diameters greater than 14-inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.	
B.	Water Mains: Water mains include water piping having diameters 4 through 14-inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.	
C.	Water Service Lines: Water service lines include water piping from a water main to a building service at a point approximately 5 feet from building or the point indicated on the drawings, specific materials, methods	

of joining and any appurtenances deemed necessary for a satisfactory system.

1.3 ACTION SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 013300 SUBMITTAL PROCEDURES:

- A. SD-01 Preconstruction Submittals
 - 1. Connections; G
- B. SD-03 Product Data
 - 1. Pipe, Fittings, Joints and Couplings; G
 - 2. Valves; G
 - 3. Pipe Restraint; G
 - 4. Tapping Sleeves; G
 - 5. Disinfection Procedures; G
- C. SD-06 Test Reports
 - 1. Bacteriological Samples; G
 - 2. Post-Construction Fusion Report; G
 - 3. Leakage Report
 - 4. Hydrostatic Test
- D. SD-08 Manufacturer's Instructions
 - 1. PVC Piping
 - 2. PVC Piping for Service Lines

1.4 QUALITY CONTROL

- A. Regulatory Requirements: Comply with NSF/ANSI 14 or NSF/ANSI 61 and NSF 372 for materials for potable water systems; comply with lead content requirements for "lead-free" plumbing as defined by the U.S. Safe Drinking Water Act effective January 2014. Provide materials bearing the seal of the National Sanitation Foundation (NSF) for potable water service. Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, fire hydrants, and other accessories free of dirt and debris.
- B. Handling: Handle pipe, fittings, valves, fire hydrants, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to the Government. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight. Handle ductile iron pipe, fittings, and accessories in accordance with AWWA C600 and AWWA M41. Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605. Handle PE pipe, fittings, and accessories in accordance with AWWA M55.

PART 2 - PRODUCTS

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

2.1 PIPE, FITTINGS, JOINTS, AND COUPLINGS

- A. Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

2.2 PVC PIPING

- A. AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class 150 (DR27.5), 235 (DR18), with ductile iron outside diameter (DIOD).

2.3 FITTINGS FOR PVC PIPING

- A. Gray iron or ductile iron fittings, AWWA C110/A21.10 with special fittings in accordance with Appendix B or AWWA C153/A21.53, with cement-mortar lining for fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design compatible for use with PVC pipe as specified.

2.4 JOINTS AND JOINTING MATERIAL FOR PVC PIPING

- A. Push-on joints: Use jointing material in accordance with ASTM D3139 and AWWA C111/A21.11 between pipes, pipes and metal fittings, valves, and other accessories or compression-type joints/mechanical joints. Provide each joint connection with an elastomeric gasket compatible for the bell or coupling used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints.
- B. Mechanical Joint: Use mechanically coupled joints having a sleeve-type mechanical coupling, as specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS, as an optional jointing method for plain-end PVC pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling as specified for compression-type joints in ASTM D3139. Provide jointing material in accordance with AWWA C111/A21.11 between pipe and sleeve-type mechanical couplings.

2.5 PVC PIPING FOR SERVICE LINES

- A. Pipe and Fittings: Provide ASTM D1784 cell class 12454 pipe and fittings of the same PVC material.
 1. ASTM D1785, Schedule 40 with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.
 2. ASTM D2241 pipe and fittings with SDR as necessary to provide 150 psi minimum pressure rating with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.
- B. Joints and Connections: Fittings may be joined by the solvent-cement method or threading.
- C. Solvent Joining: Provide solvent joints in accordance with ASTM D2855.

2.6 VALVES

- A. Provide a protective interior coating in accordance with AWWA C550.
- B. Gate Valve 3 Inch Size and Larger: AWWA C500, AWWA C509, AWWA C515, or UL 262 and:
 1. AWWA C500: non-rising stem type with double-disc gate and mechanical-joint ends or push-on joint ends compatible for the adjoining pipe.
 2. AWWA C509 or AWWA C515: non-rising stem type with mechanical-joint ends or resilient-seated gate valves 3 to 12 inches in size.
 3. UL 262: inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 175 psi, and have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined.

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. Gate valves open by counterclockwise rotation of the valve stem. Stuffing boxes have O-ring stem seals, except for those valves for which gearing is specified, in which case use conventional packing in place of O-ring seal. Stuffing boxes are bolted and constructed so as to permit easy removal of parts for repair. Use gate valves with special ends for connection to cement piping or sleeve-type mechanical coupling in lieu of mechanical-joint ends and push-on joint ends. Provide valve ends

and gaskets for connection to cement piping or to sleeve-type mechanical couplings that conform to the requirements specified respectively for the coupling. Provide AWWA C500 8-inch gate valves with gearing and indicator. Provide all valves from one manufacturer.

- C. Check Valves: Provide a protective interior coating in accordance with AWWA C550. Swing-check type, AWWA C508 or UL 312 and:
 - 1. AWWA C508: Iron or steel body and cover and flanged ends.
 - 2. UL 312: Cast iron or steel body and cover, flanged ends, and designed for a minimum working pressure of 200 psi.

Materials for UL 312 check valves are to match the reference standards specified in AWWA C508. Provide check valves with a clear port opening. Provide weight-loaded check valves where indicated. Provide all check valves from one manufacturer.

2.7 WATER SERVICE VALVES

- A. Gate Valves Smaller than 3 Inch in Size on Buried Piping: Gate valves smaller than 3-inch size on Buried Piping MSS SP-80, Class 150, solid wedge, non-rising stem, with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.
- B. Gate Valves Smaller than 3 Inch Size in Valve Pits: MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Provide valves with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.
- C. Check Valves Smaller than 2 Inch in Size: Provide check valves with a minimum working pressure of 150 psi or as indicated with a clear waterway equal to the full nominal diameter of the valve. Valves open to permit flow when inlet pressure is greater than the discharge pressure, and close tightly to prevent return flow when discharge pressure exceeds inlet pressure. Cast the size of the valve, working pressure, manufacturer's name, initials, or trademark on the body of each valve. Provide valves for screwed fittings, made of lead-free bronze and in conformance with MSS SP-80, Class 150, Types 3 and 4 compatible for the application.

2.8 BLOWOFF VALVE ASSEMBLIES

- A. Provide blowoff valve assemblies complete with all pipes, fittings, valve, valve box, riser box and lid, riser extension, discharge fitting and other materials required to connect to the water main. Provide blowoff valve assemblies 4 inches or larger with AWWA C110/A21.10 or AWWA C153/A21.53 fittings. Provide a blowoff valve assembly with a removable riser.

2.9 METERS

Submit certificates certifying all required and recommended tests set forth in the referenced standard and AWWA M6 have been performed and comply with all applicable requirements of the referenced standard and AWWA M6 within the past three years. Include certification that each meter has been tested for accuracy of registration and that each meter complies with the accuracy and capacity requirements of the referenced standard when tested in accordance with AWWA M6. Include a register with all meters whether they are or are not connected to a remote reading system.

- A. Turbine Type Meters: Provide AWWA C701 Class I Class II meter with a strainer screen. Main casing constructed of with protective coating in accordance with AWWA C213 or AWWA C550.
- B. Register: Provide AWWA C700 straight-reading register supplied by the meter manufacturer. Equip register with U.S. gallons readings. Use a direct reading remote register designed in accordance with AWWA C706 an encoder type remote register designed in accordance with AWWA C707.
- C. Strainers: Provide AWWA C702 strainer recommended and supplied by the meter manufacturer. Provide strainer of the same material as the meter body (i.e., bronze, ductile, or stainless).
- D. Meter Connections: Provide main case connection fittings.

- E. Meter Boxes: Provide meter boxes of sufficient size to completely enclose the meter and shutoff valve or service stop and in accordance with the details shown on the drawings. Provide a meter boxes or vaults with a height equal to the distance from invert of the service line to finished grade at the meter location.
 - 1. Plastic: Provide manufactured plastic boxes and lids meeting the following requirements:
 - a. One-piece molded construction
 - b. Vertical load rating for medium duty use of 15,000 lbs
 - c. Ultraviolet (UV) exterior surface protection
 - d. White interior surface
 - e. Provide an ASTM A48/A48M, Class 25 cast iron ring and round lid

2.10 ACCESSORIES

- A. Thrust Blocks: Use ASTM C94/C94M concrete having a minimum compressive strength of 2,500 psi at 28 days or use concrete of a mix not leaner than one part cement, two and one half parts sand, and five parts gravel, having the same minimum compressive strength.
- B. Curb or Service Stops: Ground key, round way, inverted key type; made of lead-free bronze, ASTM B61 or ASTM B62; and compatible with the working pressure of the system. Provide compatible ends for connection to the service piping. Cast an arrow into body of the curb or service stop indicating direction of flow.
- C. Protective Enclosures: Provide Freeze-Protection Enclosures that are insulated and designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 35 degrees F when external temperatures reach as low as 0 degrees F.
- D. Tapping Sleeves: Provide cast gray, ductile, malleable iron or stainless steel, split-sleeve type tapping sleeves of the sizes indicated for connection to existing main with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Utilize similar metals for bolts, nuts, and washers to minimize the possibility of galvanic corrosion. Provide dielectric gaskets where dissimilar metals adjoin. Provide a tapping sleeve assembly with a maximum working pressure of 235 psi. Provide bolts with square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, utilize an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pre-torqued to 50 foot-pounds.
- E. Sleeve-Type Mechanical Couplings: Use couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets. For ductile iron and PVC pipe, the middle ring is cast-iron or steel; and the follower rings are malleable or ductile iron. For steel piping, the middle ring is steel, and the follower rings are steel or malleable iron. Malleable and ductile iron are to meet the requirements of ASTM A47/A47M and ASTM A536, respectively. Steel is to have a strength not less than that of the pipe. Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with nuts, ASTM A563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Provide 5/8-inch diameter bolts; minimum number of bolts for each coupling is 6, for 4-inch pipe. Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.
- F. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets.
- G. Insulating Joints: Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.
- H. Dielectric Fittings: Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar

metallic piping elements and compatible with the indicated working pressure.

- I. Tracer Wire for Nonmetallic Piping: Provide a continuous bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Connections to Existing System: Perform all connections to the existing water system in the presence of the Contracting Officer.
- B. Operation of Existing Valves: Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.
- C. Earthwork: Perform earthwork operations in accordance with Section 310000 EARTHWORK.

3.2 INSTALLATION

Install all materials in accordance with the applicable reference standard, manufacturer's instructions and as indicated herein.

- A. Piping
 1. General Requirements: Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.
 2. Termination of Water Lines: Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated. Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility.
 3. Meters: Install meters and meter [boxes] [vaults] at the locations shown on the drawings. Center meters in the [boxes] [vaults] to allow for reading and ease of removal or maintenance. Set top of box or vault at finished grade.
 4. Pipe Laying and Jointing: Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each workday, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Provide a minimum of 3 feet depth of cover over top of pipe.
 5. Tracer Wire: Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.
 6. Connections to Existing Water Lines: Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated, except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.
 7. Sewer Manholes: No water piping is to pass through or come in contact with any part of a sewer manhole.
 8. Water Piping Parallel with Sewer Piping: Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer than 10 feet, horizontally, from any sewer line.
 9. Water Piping Crossing Sewer Piping: Provide at least 18 inches above the top (crown) of the sewer piping and the bottom (invert) of the water piping whenever possible. Measure the distance edge-to-edge. Where water lines cross under gravity sewer lines, construct sewer line of AWWA compliant ductile iron water piping with rubber-gasketed joints and no joint located within 10 feet, horizontally,

- of the crossing.
10. Penetrations: Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.
 11. PVC Water Main Pipe: Unless otherwise specified, install pipe and fittings in accordance with the paragraph General Requirements and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."
 - a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type of joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type of joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.
 - b. Joint Offset: Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.
 - c. Fittings: Install in accordance with AWWA C605.
 12. Plastic Service Piping: Install pipe and fittings in accordance with the paragraph General Requirements and with the applicable requirements of ASTM D2774, unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.
 - a. Jointing: Make solvent-cemented joints for PVC piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D2855. Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
 - b. Plastic Pipe Connections to Appurtenances: Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.
 13. Fire Protection Service Lines for Sprinkler Supplies: Connect water service lines used to supply building sprinkler systems for fire protection to the water main in accordance with NFPA 24.
- B. Disinfection: Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of wastewater from disinfection as part of the disinfection submittal. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Disinfect new water piping using the AWWA C651 continuous-feed method of chlorination. Ensure a free chlorine residual of not less than 10 parts per million after 24 hour holding period and prior to performing bacteriological tests.
- C. Flushing: Perform bacteriological tests prior to flushing. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 parts per million, the residual chlorine content of the distribution system, or acceptable for domestic use. Use AWWA C655 neutralizing chemicals.
- D. Pipe Restraint
1. Concrete Thrust Blocks: Install concrete thrust blocks where indicated.
 2. Restrained Joints: Install restrained joints in accordance with the manufacturer's instructions where indicated. For metal harness use tie rods and clamps as shown in NFPA 24.

- E. Valves
 - 1. Gate Valves: Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.
 - 2. Check Valves: Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation, except as otherwise indicated. Make and assemble joints to check valves as specified for making and assembling the same type joints between pipe and fittings.
- F. Blowoff Valve Assemblies: Install blowoff valve assemblies as indicated on the drawings or in accordance with the manufacturer's recommendations. Install discharge fitting on the end of riser pipe to direct the flow of water so as to minimize damage to surrounding areas.

3.3 FIELD QUALITY CONTROL

- A. Tests: Notify the Contracting Officer a minimum of five days in advance of hydrostatic testing. Coordinate the proposed method for disposal of wastewater from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing, except that water needed for field tests will be furnished as set forth in paragraph USE AND AVAILABILITY in Section 010200 UTILITIES. Provide documentation that all items of work have been constructed in accordance with the Contract documents.
 - 1. Hydrostatic Test: Test the water system in accordance with the applicable AWWA standard specified below. Where water mains provide fire service, test in accordance with the special testing requirements given in the paragraph SPECIAL TESTING REQUIREMENTS FOR FIRE SERVICE and as set forth by Section 211313 WET PIPE SPRINKLER SYSTEMS. Test PVC plastic water systems made with PVC pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC water main pipe is not to exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed. Test water service lines in accordance with requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at copper pipe joints, copper tubing joints (soldered, compression type, brazed), plastic pipe joints, flanged joints, screwed joints. Do not backfill utility trench or begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 7 days after placing of the concrete.
 - 2. Leakage Test: For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.
 - 3. Bacteriological Testing: Perform bacteriological tests in accordance with AWWA C651 Option A. For new water mains use Option A and obtain two sets of samples for coliform analysis, each sample being collected at least 16 hours apart. Take samples every 1,200 ft plus one set from the end of the line and at least one from each branch greater than one pipe length. Analyze samples by a certified laboratory and submit the results of the bacteriological samples.
 - 4. Special Testing Requirements for Fire Service: Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24.
 - 5. Tracer Wire Continuity Test: Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.

3.4 SYSTEM STARTUP

- A. Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.

3.5 CLEANUP

- A. Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

END OF SECTION 331100

SECTION 331123 – NATURAL GAS AND LIQUID PETROLEUM PIPING

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. All publications shall be the latest version/edition/revision of the documents listed below, in effect on the date of this solicitation, except where a date is given.

A. AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.1	(2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity)
AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA ANSI B109.3	(2019) Rotary-Type Gas Displacement Meters
AGA ANSI B109.4	(2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.41/CSA 6.9	(2014; R 2019) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.45	(1995) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
ANSI Z21.69/CSA 6.16	(2015; R 2020) Connectors for Movable Gas Appliances

C. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.33	(2012; R 2017) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, (Sizes NPS 1/2 - NPS 2)
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.40	(2019) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems

ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
D. ASTM INTERNATIONAL (ASTM)	
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2022a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High-Pressure or High Temperature Service, or Both
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
E. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)	
MSS SP-58	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
MSS SP-69	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
F. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 54	(2021) National Fuel Gas Code
G. U.S. DEPARTMENT OF DEFENSE (DOD)	
MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
H. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)	
49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
49 CFR 195	Transportation of Hazardous Liquids by Pipeline

1.2 RELATED REQUIREMENTS

Section 23 11 23 FACILITY NATURAL-GAS PIPING applies to this section, with additions and modifications specified herein.

1.3 ACTION SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

- A. SD-03 Product Data
 - 1. Valve Box
 - 2. Pressure Regulator
 - 3. Gas Equipment Connectors
 - 4. Valves
 - 5. Warning and Identification Tape
 - 6. Risers
 - 7. Transition Fittings
 - 8. Gas Meter
- B. SD-07 Certificates
 - 1. Welder's Qualifications
 - 2. PE Welder's Qualifications
 - 3. Welder's Identification Symbols
- C. SD-08 Manufacturer's Instructions
 - 1. PE Pipe and Fittings

1.4 QUALITY ASSURANCE

- A. Welder's Qualifications: Comply with ASME B31.8. The steel welder shall have a copy of a certified ASME B31.8 qualification test report. The PE welder shall have a certificate from a PE pipe manufacturer's sponsored training course. Contractor shall also conduct a qualification test. Submit each welder's identification symbols, assigned number, or letter, used to identify work of the welder. Affix symbols immediately upon completion of welds. Welders making defective welds after passing a qualification test shall be given a requalification test and, upon failing to pass this test, shall not be permitted to work this contract.
- B. PE Welder's Qualifications: Prior to installation, Contractor shall have supervising and installing personnel trained by a PE pipe manufacturer's sponsored course of not less than one week duration, or present proof satisfactory to the Contracting Officer that personnel are currently working in the installation of PE gas distribution lines.
- C. Safety Standards: 49 CFR 192 [and 49 CFR 195].

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe ends during transportation or storage to minimize dirt and moisture entry. Do not subject to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.

PART 2 - PRODUCTS

2.1 CONDUITS, DUCT, AND FITTINGS

- A. Conform to NFPA 54 and with requirements specified herein. Supply piping to appliances or equipment shall be at least as large as the inlets thereof.

2.2 PIPE AND FITTINGS

- A. Aboveground and Within Buildings and Vaults:
 - 1. Pipe: Black steel in accordance with ASTM A53/A53M, Schedule [40] [80], threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.
 - 2. Threaded Fittings: ASME B16.3, black malleable iron.

3. Socket-Welding Fittings: ASME B16.11, forged steel.
 4. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.
 5. Unions: ASME B16.39, black malleable iron.
 6. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.
- B. Underground Polyethylene (PE): PE pipe and fittings are as follows:
1. Pipe: ASTM D2513, 100 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum.
 2. Socket Fittings: ASTM D2683.
 3. Butt-Fusion Fittings: ASTM D2513, molded.
- C. Risers: Manufacturer's standard riser, transition from plastic to steel pipe with 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide [remote bolt-on or bracket] [or] [wall-mounted] riser supports [as indicated].
- D. Transition Fittings: identified for direct burial.
1. Steel to Plastic (PE): As specified for "riser" except designed for steel-to-plastic with tapping tee or sleeve. Coat or wrap exposed steel pipe with heavy plastic coating.
 2. Plastic to Plastic: [Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support, O-ring seals, and rated for 150 psig gas service.] [Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.]

2.3 SHUTOFF VALVES, BELOW GROUND

- A. Metallic Ball Valves: [ASME B16.33] corrosion-resisting steel, with threaded or flanged ends. Provide polytetrafluoroethylene (PTFE) seats.
- B. PE Ball or Plug Valves: ASME B16.40 and ASTM D2513, Class C materials (PE 2306 or PE 3406), strength rating of Class [3 location with class factor of 0.25], and SDR matching PE pipe dimensions and working pressure.

2.4 VALVES, ABOVEGROUND

Provide lockable valves where indicated.

- A. Shutoff Valves, Sizes 2 Inches and Smaller: [Bronze] body ball valve in accordance with ASME B16.33, full port pattern, reinforced PTFE seals, threaded ends, and PTFE seat.]
- B. Line Appliance Pressure Regulator and Shutoff Valve: Provide regulators conforming to [ANSIZ21.18/CSA 6.3 for appliances] [ANSI Z21.78/CSA 6.20 for combination gas controls for gas appliances] [, and ANSI Z21.80/CSA 6.22 for line pressure regulators]. Provide shutoff valves conforming to [ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves] [and] [ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances].
- C. Service Regulators:
1. Provide ferrous bodied pressure regulators for individual service lines, capable of reducing distribution line pressure to pressures required for users. Provide service regulators conforming to AGA ANSI B109.4 CGA-6.18-M95 with full capacity internal relief [and overpressure shutoff]. Set pressure relief at a lower pressure than would cause unsafe operation of any connected user.
 2. Adjust regulators for liquified petroleum gas to 10 to 12 inches of water column, with pressure relief set at 16 inches of water column.
 3. Provide regulator(s) having a single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas flow rate at the regulator inlet pressure. Provide regulator valve vent of resilient materials designed to withstand flow conditions when pressed against the valve port, capable of regulating downstream pressure within limits of accuracy and limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Provide a self-contained service regulator, and pipe not exceeding exceed 2-inch size.

2.5 GAS METER

[AGA ANSI B109.1] [AGA ANSI B109.2] [AGA ANSI B109.3] [pipe] [pedestal] mounted, [diaphragm] or [bellow] [style],

[cast-iron] [enamel coated steel] [aluminum] case. [Provided with a strainer immediately upstream]. Provide [diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above] [rotary-type displacement meter conforming to AGA ANSI B109.3] as required by local gas utility supplier. Provide combined [odometer-type] register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that are tamper-proof [with] [frost protection] [fungus protection] [seismic protection]. Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 100 cubic feet of gas. Minimum service life shall be 30,000,000 cycles.

- A. Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control Systems (EMCS): Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS / EMCS for data gathering in units of cubic feet. Provide meters that do not require power to function and deliver data. Output signal shall be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor.

2.6 GAS EQUIPMENT CONNECTORS

- A. Flexible Connectors: ANSI Z21.45.
- B. Quick Disconnect Couplings: ANSI Z21.41/CSA 6.9.
- C. Semi Rigid Tubing and Fittings: ANSI Z21.69/CSA 6.16.

2.7 VALVE BOX

Provide [rectangular concrete valve box, sized large enough for removal of valve without removing box]. Cast the word "Gas" into the box cover. Use valve box for areas as follows:

- A. Heat Shrinkable Joint: Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.
- B. Cold Shrink Rubber Type Joint: Joint must be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket must be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice should be packaged three splices per kit, including complete installation instructions.

2.8 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

Provide detectable aluminum-foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3-inch minimum width, color-coded yellow for natural gas, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED GAS PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.9 HANGERS AND SUPPORTS

MSS SP-58, as required by MSS SP-69.

2.10 WELDING FILLER METAL

ASME B31.8.

2.11 PIPE-THREAD TAPE

- A. Antiseize and sealant tape of polytetrafluoroethylene (PTFE).

2.12 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; ASTM A193/A193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194/A194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts shall conform with ASME B18.2.1 and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs shall extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts shall have American Standard regular square or heavy hexagon heads; nuts shall be American Standard heavy semifinished hexagonal.

2.13 GASKETS

Provide Fluorinated elastomer, compatible with flange faces.

2.14 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 3/4 inch od, provide brass identification tags 1 1/2 inches in diameter with legends in depressed, black-filled characters.

PART 3 – EXECUTION

3.1 INSTALLATION

Install gas piping, appliances, and equipment in accordance with NFPA 54. [Install distribution piping in accordance with ASME B31.8.]

- A. Excavating and Backfilling: Perform excavating and backfilling of pipe trenches as specified in Section 31 00 00 EARTHWORK. Place pipe directly in trench bottom and cover with minimum 3 inches of sand to top of pipe. If trench bottom is rocky, place pipe on a 3-inch bed of sand and cover as above. Provide remaining backfilling. Coordinate provision of utility warning and identification tape with backfill operation. Bury utility warning and identification tape with printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.
- B. Piping: Cut pipe to actual dimensions and assemble to prevent residual stress. [Provide supply connections entering the buildings as indicated.] Within buildings, run piping parallel to structure lines and conceal in finished spaces. Terminate each vertical supply pipe to burner or appliance with tee, nipple, and cap to form a sediment trap. To supply multiple items of gas-burning equipment, provide manifold with inlet connections at both ends.
 1. Cleanliness: Clean inside of pipe and fittings before installation. Blow lines clear using 80 to 100 psig clean dry compressed air. Rap steel lines sharply along entire pipe length before blowing clear. Cap or plug pipe ends to maintain cleanliness throughout installation.
 2. Aboveground Steel Piping: Determine and establish measurements for piping at the job site and accurately cut pipe lengths accordingly. For 2-inch diameter and smaller, use threaded or socket-welded joints. For 2 1/2-inch diameter and larger, use flanged or butt-welded joints.
 - a. Threaded Joints: Where possible use pipe with factory-cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Provide threads smooth, clean, and full cut. Apply anti-seize paste or tape to male threads portion. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that no more than three threads remain exposed. Use unions for connections to [valves] [meters] for which a means of disconnection is not otherwise provided.
 - b. Welded Joints: Weld by the shielded metal-arc process, using covered electrodes and in accordance with procedures established and qualified in accordance with ASME B31.8.
 - c. Flanged Joints: Use flanged joints for connecting welded joint pipe and fittings to valves to provide for disconnection. Install joints so that flange faces bear uniformly on gaskets. Engage bolts so that there is complete threading through the nuts and tighten so that bolts are uniformly stressed and equally torqued.
 - d. Pipe Size Changes: Use reducing fittings for changes in pipe size. Size changes made with bushings will not be accepted.
 - e. Painting: Paint new ferrous metal piping, including supports, in accordance with Section 09 91 23 INTERIOR PAINTING. Do not apply paint until piping tests have been completed.
 - f. Identification of Piping: Identify piping aboveground in accordance with MIL-STD-101, using adhesive-backed or snap-on plastic labels and arrows. In lieu of labels, identification tags may

- be used. Apply labels or tags to finished paint at intervals of not more than 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.
3. Buried Plastic Lines: Provide totally PE piping. Prior to installation, obtain printed instructions and technical assistance in proper installation techniques from pipe manufacturer. [When joining new PE pipe to existing pipeline, ascertain what procedural changes in the fusion process is necessary to attain optimum bonding.]
 - a. Jointing Procedures: Use jointing procedures conforming to AGA XR0603 and 49 CFR 192 that have been qualified by test in accordance with 49 CFR 192.283 and proven to make satisfactory joints. Personnel making joints in plastic pipe shall be qualified in accordance with 49 CFR 192.285, under the submitted and approved procedure by making a satisfactory specimen joint that passes the required inspection and test. Joints in plastic pipe shall be inspected by a person qualified by 49 CFR 192.287 under the applicable procedure. Certificates that qualify the applicable procedures, joining personnel, and inspectors shall be submitted and approved and shall be on file with the Contracting Officer prior to making these joints.
 - b. PE Piping: Prior to installation, Contractor shall have supervising and installing personnel, certified in accordance with paragraph WELDER'S QUALIFICATIONS. Provide fusion-welded joints except where transitions have been specified. Use electrically heated tools, thermostatically controlled, and equipped with temperature indication. (Where connection must be made to existing plastic pipe, contractor shall be responsible for determination of compatibility of materials and procedural changes in fusion process necessary to attain maximum integrity of bond.)
 - c. Laying PE Pipe: Bury pipe 24 inches below finish grade [or deeper when indicated]. Lay in accordance with manufacturer's printed instructions.
 4. Connections to Existing Pipeline: When making connections to live gas mains, use pressure tight installation equipment operated by workmen trained and experienced in making hot taps. For connections to existing underground pipeline or service branch, use transition fittings for dissimilar materials.
 5. Wrapping: Where connection to existing steel line is made underground, tape wrap new steel transition fittings and exposed existing pipe having damaged coating. Clean pipe to bare metal. Initially stretch first layer of tape to conform to the surface while spirally half-lapping. Apply a second layer, half-lapped and spiraled as the first layer, but with spirals perpendicular to first wrapping. Use 0.025 mm 10 mil minimum thick polyethylene tape. In lieu of tape wrap, heat shrinkable 0.025 mm 10 mil minimum thick polyethylene sleeve may be used.
- C. Valves: Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. [Provide support for valves to resist operating torque applied to PE pipes.]
1. Stop Valve and Shutoff Valve: Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.
- D. Gas Service Installation: Installations shall be in accordance with 49 CFR 192 and ASME B31.8. Contractor shall submit and use only tested and approved work procedures. Contractor shall use only welders and jointers who have been recently qualified by training and test for joining and installing the gas pipe material used on this job. The finished product shall be inspected by a person qualified to inspect joints made by the particular procedures used to make joints.
1. Service Line: Install service line, branch connection to the main, and riser in accordance with 49 CFR 192 and ASME B31.8. Provide a minimum of 18 inches cover or encase the service line so that it is protected. Install service line so that no undue stress is applied to the pipe, connection, or riser. Install approved riser and terminate with an approved isolation valve, EFV and automatic shutoff device. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK. Where steel pipe is used as service line, install corrosion prevention coating and cathodic protect for the steel service line. Where connected to an existing cathodically protected steel pipe, ensure electrical continuity from the riser to the branch connection to the main. Install a dielectric fitting on the riser to prevent electrical continuity to the above ground piping. Where plastic pipe is used as the service line, make joints in accordance with procedures qualified by test. Personnel joining plastic pipe shall be qualified by making a satisfactory specimen joint that passes the required inspection and test listed in 49 CFR 192.285. Inspection shall be made by inspectors qualified in evaluating joints made under the specific joining procedure, as required by 49 CFR 192.287.
 2. Service Regulator: Install service regulator in accordance with 49 CFR 192 and ASME B31.8 and this specification ensuring that the customer's piping is protected from over pressurization should the service regulator fail. A 3/8 inch tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. For inside installations, route the regulator vent pipe through the exterior wall to the atmosphere, and seal building penetrations for service line and vent. Terminate the regulator vent so that it is protected from precipitation and insect intrusion, so that it is not submerged during floods, and so that gas escaping will not create a hazard or enter the building through openings.
 3. Gas Meter: Install shutoff valve, meter set assembly, and service regulator on the service line, 18 inches above the [ground] on the riser. An insulating joint (dielectric connection) shall be installed on the inlet

side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current.

- E. Pipe Sleeves: [Comply with Section 07 84 00 FIRESTOPPING.] Where piping penetrates concrete or masonry wall, floor or firewall, provide pipe sleeve poured or grouted in place. Make sleeve of steel or cast-iron pipe of such size to provide 6 mm 1/4 inch or more annular clearance around pipe. Extend sleeve through wall or slab and terminate flush with both surfaces. Pack annular space with oakum, and caulk at ends with silicone construction sealant.
- F. Piping Hangers and Supports: Selection, fabrication, and installation of piping hangers and supports shall conform with MSS SP-69 and MSS SP-58, unless otherwise indicated.
- G. Final Connections: Make final connections to equipment and appliances using rigid pipe and fittings, except for the following:
 - 1. Domestic Water Heaters: Connect with AGA-Approved semi-rigid tubing and fittings.

3.2 FIELD QUALITY CONTROL

- A. Metal Welding Inspection: Inspect for compliance with [NFPA 54] [and] [ASME B31.8] and 49 CFR 192. Replace, repair, and then re-inspect defective welds.
- B. PE Fusion Welding Inspection: Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect 100 percent of all joints and reinspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer to make first time inspection.
- C. Pressure Tests: Use test pressure of 1 1/2 times maximum working pressure, but in no case less than 50 psig. Do not test until every joint has set and cooled at least 8 hours at temperatures above 50 degrees F. Conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Test system gas tight in accordance with [NFPA 54] [or] [ASME B31.8]. Use clean dry air or inert gas, such as nitrogen or carbon dioxide, for testing. Systems which may be contaminated by gas shall first be purged as specified. Make tests on entire system or on sections that can be isolated by valves. After pressurization, isolate entire piping system from sources of air during test period. Maintain test pressure for at least 8 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes. Provide temperature same as actual trench conditions. There shall be no reduction in the applied test pressure other than that due to a change in ambient temperature. Allow for ambient temperature change in accordance with the relationship $PF + 101.32 = (P1 + 101.32) (T2 + 273) / T1 + 273$ $PF + 14.7 = (P1 + 14.7) (T2 + 460) / T1 + 460$, in which "T" and "PF" represent Centigrade Fahrenheit temperature and gage pressure, respectively, subscripts "1" and "2" denote initial and final readings, and "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by 1/2 psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient temperature change. Repair leaking joints and repeat test until no reduction in pressure occurs. In performing tests, use a test gage calibrated in 1 psi increments and readable to 1/2 psi.
- D. System Purging: After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clear completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures shall conform to [NFPA 54] [and] [ASME B31.8].

END OF SECTION 331123

SECTION 333000 – SANITARY SEWERAGE

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. All publications shall be the latest version/edition/revision of the documents listed below, in effect on the date of this solicitation, except where a date is given.

A. ASTM INTERNATIONAL (ASTM)

ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	(2021) Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

B. UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
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1.2 ACTION SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

- A. SD-01 Preconstruction Submittals
 - 1. Contractor's License; G
- B. SD-02 Shop Drawings
 - 1. Installation Drawings; G
- C. SD-03 Product Data
 - 1. Gravity Pipe
- D. SD-06 Test Reports
 - 1. Low Pressure Air Tests; G
 - 2. Deflection Testing
- E. SD-07 Certificates
 - 1. Gaskets

2. Pre-Installation Inspection Request; G
3. Post-Installation Inspection; G

1.3 QUALITY CONTROL

- A. Installer Qualifications: Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified or state registered.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials. Inspect materials delivered to site for damage, store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
- B. Handling: Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. [Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs.] Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 - PRODUCTS

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification, standard drawings, or catalog cuts.

2.1 SYSTEM DESCRIPTION

- A. Sanitary Sewer Gravity Pipeline: [Provide [laterals] [4 inch lines] of [polyvinyl chloride (PVC) plastic pipe]. Provide building connections [4 inch lines] of [polyvinyl chloride (PVC) plastic pipe].] [Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 1.5 m 5 feet outside of building walls.]

2.2 MATERIALS

- A. PVC Gravity Sewer Piping, Fittings, and Joints: [ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.] Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.

PART 3 – EXECUTION

3.1 PREPARATION

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

- A. Connections to Existing Lines: Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.
- B. General Requirements for Installation of Pipelines: These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

1. Location: Terminate the work covered by this section at a point approximately 1.5 m 5 feet from the building, [unless otherwise indicated]. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 0.60 m 2 feet below bottom of water line. When these separation distances can not be met, contact the Contracting Officer for direction.
2. Earthwork: Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.
3. Pipe Laying and Jointing: Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell [or groove] ends in the upgrade direction. Adjust spigots in bells [and tongues in grooves] to give a uniform space all around. Blocking or wedging between bells and spigots [or tongues and grooves] will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 7.50 m 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

C. Special Requirements

1. Installation of PVC Piping: Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
- D. Installations of Wye Branches: Install wye branches in an existing sewer using a method which does not damage the integrity of the existing sewer. Do not cut into piping for connections except when approved by the Contracting Officer. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, support on a concrete cradle as directed by the Contracting Officer. Provide and install concrete required because of conditions resulting from faulty construction methods or negligence without any additional cost to the Government. Do not damage the existing sewer when installing wye branches in an existing sewer.

E. Piping

1. Penetrations: Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.
2. Flanged Pipe: Only install flanged pipe aboveground or with the flanges in valve pits.

3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

A. Tests: Perform field tests and provide labor, equipment, and incidentals required for testing.

1. Leakage Test for Nonpressure Lines: Test lines for leakage by low-pressure air tests. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.
 - a. Low Pressure Air Tests:
 - a. PVC Pipelines: Test PVC pipe in accordance with UBPPA UNI-B-6. The allowable pressure drop is located in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.
2. Deflection Testing: Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads is not to exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

3. Dye Test: Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Use nontoxic non-staining sewer tracing dye. Test results are to be noted as required in Section 01 32 00 CONSTRUCTION PROGRESS DOCUMENTATION.
 - a. Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.
 - b. During the test, monitor the storm drainage system downstream from the project, either manholes or outfalls, for any sign of cross-connection.
4. Smoke Test: Perform a smoke test on the relevant portion of the sewer system. Test results are to be noted as required in Section 01 32 00 CONSTRUCTION PROGRESS DOCUMENTATION.
 - a. Continue testing until it can be visually confirmed that the projects sanitary sewer point of connection has not been cross-connected to the storm drainage system.
 - b. During the test, monitor the storm drainage system, either manholes or outfalls, for any sign of cross-connection.

B. INSPECTION

1. Pre-Installation Inspection: Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit pre-installation inspection request for field support at least [14] [...] days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.
2. Post-Installation Inspection: Perform a post-installation inspection after connection has been made and before the connection is buried. Submit post-installation inspection request for field support at least [14] [...] days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection. [During the post-installation inspection the Contractor will be responsible for performing a [dye test] [smoke test].]

END OF SECTION 333000

SECTION 337102 – UNDERGROUND ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. All publications shall be the latest version/edition/revision of the documents listed below, in effect on the date of this solicitation, except where a date is given.

A. AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318M	(2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary
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ACI SP-66	(2004) ACI Detailing Manual
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B. ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
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ASTM B3	(2013) Standard Specification for Soft or Annealed Copper Wire
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ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
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ASTM B231/B231M	(2016; R 2021) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
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ASTM B400/B400M	(2019) Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors
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ASTM B496	(2016; R 2021) Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
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ASTM B609/B609M	(2012; R 2021) Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical purposes
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ASTM B800	(2005; R 2021) Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers
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ASTM B801	(2018) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
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ASTM C32	(2013; R 2017) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
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ASTM C139	(2022) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
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ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
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ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
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ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C857	(2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C990M	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM F512	(2019) Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
ASTM F2160	(2022a) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)

C. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 400.2	(2013) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE 495	(2007) Guide for Testing Faulted Circuit Indicators
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

D. INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-94-649	(2021) Concentric Neutral Cables Rated 5 Through 46 KV
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E. INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
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F. NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

ANSI C119.1	(2016) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
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ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Non-shielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
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NEMA C119.4	(2011) Electric Connectors - Connectors for Use Between Aluminum-to-Aluminum or Aluminum-to-Copper Conductors Designed for Normal Operation at or Below 93 Degrees C and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100 Degrees C
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NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
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NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
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NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
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NEMA TC 6 & 8	(2020) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
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NEMA TC 7	(2021) Smooth-Wall Coilable and Straight Electrical Polyethylene Conduit
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NEMA TC 9	(2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
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NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
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NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
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G. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
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H. TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-758	(2012b) Customer-Owned Plant Telecommunications Infrastructure Standard
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I. U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1751F-644	(2002) Underground Plant Construction
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J. U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005

(Basic; Notice 2) Frames, Covers, Gratings, Steps,
Sump and Catch Basin, Manhole

K. UNDERWRITERS (UL)

UL 44

(2018; Reprint May 2021) UL Standard for Safety
Thermoset-Insulated Wires and Cables

UL 83

(2017; Reprint Mar 2020) UL Standard for Safety
Thermoplastic-Insulated Wires and Cables

UL 94

(2023) UL Standard for Safety Tests for Flammability of
Plastic Materials for Parts in Devices and Appliances

UL 467

(2022) UL Standard for Safety Grounding and Bonding
Equipment

UL 486A-486B

(2018; Reprint May 2021) UL Standard for Safety Wire
Connectors

UL 510

(2020; Dec 2022) UL Standard for Safety Polyvinyl
Chloride, Polyethylene and Rubber Insulating Tape

UL 514A

(2013; Reprint Jun 2022) UL Standard for Safety
Metallic Outlet Boxes

UL 514B

(2012; Reprint May 2020) Conduit, Tubing and Cable
Fittings

UL 651

(2011; Reprint May 2022) UL Standard for Safety
Schedule 40, 80, Type EB and A Rigid PVC Conduit
and Fittings

UL 854

(2020; Reprint Jan 2022) Standard for Service-
Entrance Cables

UL 1072

(2006; Reprint Apr 2020) Medium-Voltage Power
Cables

UL 1242

(2006; Reprint Apr 2022) UL Standard for Safety
Electrical Intermediate Metal Conduit -- Steel

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.
- B. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.
- C. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.4 ACTION SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

- A. SD-02 Shop Drawings
 - 1. Aluminum Conductors; G
 - 2. Precast Underground Structures; G

 - B. SD-03 Product Data
 - 1. Medium Voltage Cable; G
 - 2. Medium Voltage Cable Joints; G
 - 3. Medium Voltage Cable Terminations; G
 - 4. Live End Caps; G
 - 5. Precast Concrete Structures; G
 - 6. Sealing Material
 - 7. Pulling-In Irons
 - 8. Manhole Frames and Covers; G
 - 9. Handhole Frames and Covers; G
 - 10. Composite/Fiberglass Handholes; G
 - 11. Cable Supports; G
 - 12. Protective Devices and Coordination Study; G

 - C. SD-06 Test Reports
 - 1. Medium Voltage Cable Qualification and Production Tests; G
 - 2. Field Acceptance Checks and Tests; G
 - 3. Arc-proofing Test for Cable Fireproofing Tape; G
 - 4. Cable Installation Plan and Procedures; G

 - D. SD-07 Certificates
 - 1. Cable Splicer/Terminator; G
 - 2. Cable Installer Qualifications; G
 - 3. Directional Boring Certificate of Conformance; G
- 1.5 QUALITY ASSURANCE
- A. Precast Underground Structures: Submittal required for each type used. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:
 - 1. Material description
 - 2. Manufacturer's printed assembly and installation instructions
 - 3. Design calculations
 - 4. Reinforcing shop drawings in accordance with ACI SP-66
 - 5. Plans and elevations showing opening and pulling-in iron locations and details

 - B. Certificate of Competency for Cable Splicer/Terminator: The cable splicer/terminator must have a certification from the National Cable Splicing Certification Board (NCSCB) in the field of splicing and terminating shielded medium voltage (5 kV to 35 kV) power cable using pre-manufactured kits (pre-molded, heat-shrink, cold shrink). Submit "Proof of Certification" for approval, for the individuals that will be performing cable splicer and termination work, 30 days before splices or terminations are to be made.

 - C. Cable Installer Qualifications: Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers. Cable installer must demonstrate experience with a minimum of three medium voltage cable installations. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for an alternate qualified cable installer.

 - D. Directional Boring Certificate of Conformance: Provide certification of compliance with the registered Professional Engineer's design requirements for each directional bore, including: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, conductor size and type and any conductor derating due to depth of conduit. Record location and depth of all directional-bore installed HDPE conduits using Global Positioning System (GPS) recording means with "resource grade" accuracy.

 - E. Regulatory Requirements: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the

mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent requirements are specified or indicated.

- F. Standard Products: Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.
1. Alternative Qualifications: Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
 2. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

PART 2 - PRODUCTS

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

2.1 CONDUITS, DUCT, AND FITTINGS

- A. Rigid Metal Conduit: UL 6.
1. Rigid Metallic Conduit, PVC Coated: NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.
- B. Intermediate Metal Conduit: UL 1242.
1. Intermediate Metal Conduit, PVC Coated: NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.
- C. Plastic Conduit for Direct Burial and Riser Applications: UL 651 and NEMA TC 2, [EPC-40] [or] [EPC-80] [as indicated].
- D. Plastic Duct for Concrete Encasement: Provide [[Type EB-20] [Type EB-35] per UL 651, ASTM F512, and NEMA TC 6 & 8] [or] [Type EPC-40 per UL 651 and NEMA TC 2] [, as indicated].
- E. High Density Polyethylene (HDPE) Electrical Conduit for Directional Boring: Smoothwall, approved/listed for directional boring, minimum Schedule 80, ASTM F2160, NEMA TC 7.
- F. Duct Sealant: UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics, and concrete. Sealant must be capable of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -20 degrees F to 200 degrees F without loss of function.
- G. Fittings
1. Metal Fittings: UL 514B.
 2. PVC Conduit Fittings: [UL 514B, UL 651] [NEMA TC 3].
 3. PVC Duct Fittings: NEMA TC 9.
 4. Outlet Boxes for Steel Conduit: Outlet boxes for use with rigid or flexible steel conduit must be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and must conform to UL 514A.

2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

Insulated conductors must be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements [, or in accordance with NEMA WC 70]. Wires and cables manufactured more than [24][12] months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

- A. Conductor Types: Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller must be solid. Conductors No. 8 AWG and larger must be stranded. [Conductors No. 6 AWG and smaller must be copper. Conductors No. 4 AWG and larger may be either copper or aluminum, at the Contractor's option. Do not substitute aluminum for copper if the equivalent aluminum conductor size would exceed 500 kcmil. When the Contractor chooses to use aluminum for conductors No. 4 AWG and larger, the Contractor must: increase the conductor size to have the same ampacity as the copper size indicated; increase the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with NFPA 70; ensure that the pulling tension rating of the aluminum conductor is sufficient; relocate equipment, modify equipment terminations, resize equipment, and resolve to the satisfaction of the Contracting Officer problems that are direct results of the use of aluminum conductors in lieu of copper.] [All conductors must be copper.]
- B. Conductor Material: Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, [Type THWN/THHN conforming to UL 83] [or] [Type] XHHW][or][RHW] conforming to UL 44]. Copper conductors must be annealed copper complying with ASTM B3 and ASTM B8. [Aluminum conductors must be Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801, and must be of an aluminum alloy listed or labeled by UL as "component aluminum-wire stock (conductor material). Type 1350 is not acceptable. Intermixing of copper and aluminum conductors in the same raceway is not permitted.]
- C. Jackets: Provide multiconductor cables with overall PVC outer jacket.
- D. Direct Buried: Provide single conductor [and multi-conductor] cables identified for direct burial.
- E. In Duct: Cables must be single conductor cable. [Cables in factory installed coilable plastic duct assemblies must conform to NEMA TC 7.]
- F. Cable Marking: Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length. Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information: cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification. Color code conductors. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves, or colored electrical tape. Properly identify control circuit terminations. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals may be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems are as follows:
 - 1. 208/120 volt, three-phase
 - a. Phase A – Black
 - b. Phase B – Red
 - c. Phase C – Blue
 - 2. 480/277 volt, three-phase
 - 3. 120/240 volt, single phase: Black and Red
 - 4. On three-phase, four-wire delta system, high leg must be orange, as required by NFPA 70.

2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

- A. Provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.
 - 1. For use with copper conductors: UL 486A-486B.
 - 2. For use with aluminum conductors: UL 486A-486B. For connecting aluminum to copper, connectors must be the circumferentially compressed, metallurgically bonded type.

2.4 LOW VOLTAGE SPLICES

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

- A. Heat Shrinkable Splice: Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

- B. Cold Shrink Rubber Splice: Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.5 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than [24][12] months prior to date of delivery to the site are not acceptable. Provide single conductor type cables unless otherwise indicated.

- A. Cable Configuration: Provide [Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072] [concentric neutral underground distribution cable conforming to ICEA S-94-649] [metallic armored cables, consisting of three-conductor, multi-conductor cables, with insulation and shielding, as specified, using [a galvanized steel] [an aluminum] interlocked tape armor and thermoplastic jacket]. Provide cables manufactured for use in [duct] [or] [direct burial] applications [as indicated]. Cable must be rated [5 kV] [15 kV] [25 kV] [28 kV] [35 kV] [as indicated] with [100] [133] percent insulation level.
- B. Conductor Material: Provide concentric-lay-stranded, Class B [compact round] conductors. Provide [aluminum alloy Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801] [aluminum alloy 1350 cables, 3/4 hard minimum complying with ASTM B609/B609M and ASTM B231/B231M for regular concentric and compressed stranding or ASTM B400/B400M for compacted stranding] [soft drawn copper cables complying with ASTM B3 and ASTM B8 for regular concentric and compressed stranding or ASTM B496 for compact stranding].
- C. Insulation: Provide [ethylene-propylene-rubber (EPR) insulation conforming to the requirements of [ANSI/NEMA WC 71/ICEA S-96-659] [ANSI/NEMA WC 74/ICEAS-93-639] and [AEIC CS8] [ICEA S-94-649]] [tree-retardant cross-linked thermosetting polyethylene (XLP) insulation conforming to the requirements of NEMA WC 74/ICEA S-93-639 and [AEIC CS8] [ICEA S-94-649]].
- D. Shielding: Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper [tape] [or] [wire] shield for each phase.
- E. Neutrals: [Neutral conductors must be [copper][aluminum], employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.] [Concentric neutrals conductors must be copper, having a combined ampacity [equal to][1/3 of] the phase conductor ampacity rating.] [For high impedance grounded neutral systems, the neutral conductors from the neutral point of the transformer or generator to the connection point at the impedance must utilize [copper][aluminum] conductors, employing the same insulation level and construction as the phase conductors.]
- F. Jackets: Provide cables with a [PVC] [] jacket. [Direct buried cables must be rated for direct burial.] [Provide type UD cables with an overall jacket.] [Provide PVC jackets with a separator that prevents contact with underlying semiconducting insulating shield.]

2.6 MEDIUM VOLTAGE CABLE TERMINATIONS

IEEE 48 Class 1; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Provide terminations, where required, with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Provide terminations in a kit, including skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

- A. Cold Shrink Type: Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Design termination for installation in low or highly contaminated

indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

- B. Heat Shrinkable Type: Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is non-tracking, resists heavy atmospheric contaminants, ultraviolet rays, and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Design termination for installation in low or highly contaminated indoor or outdoor locations.
- C. Separable Insulated Connector Type: IEEE 386. Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of the loadbreak or deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points. Do not use separable connectors in manholes/handholes.
 - 1. 200 Ampere loadbreak connector ratings: Voltage: [15 kV, 95 kV BIL] [25 kV, 125 kV BIL] [35 kV, 150 kV BIL]. Short time rating: 10,000 rms symmetrical amperes.
 - 2. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL] [25 kV, 125 kV BIL] [35 kV, 150 kV BIL]. Short time rating: 25,000 rms symmetrical amperes. [Connectors must have 200 ampere bushing interface [for surge arresters] [as indicated].]
 - 3. Provide [[one][] set[s] of three grounding elbows][and][[one][] set[s] of three feed-thru inserts]. Deliver [grounding elbows] [and] [feed-thru inserts] to the Contracting Officer.
 - 4. Install one set of faulted circuit indicators, complying with IEEE 495, on the test points of each set of separable insulated connectors. Indicators must be self-powered; with automatic trip with mechanical flag indication upon overcurrent followed by loss of system voltage, and automatic reset upon restoration of system voltage. Indicators must be compact, sealed corrosion resistant construction with provision for hotstick installation and operation.

2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints must be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404. Connectors for joint must be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

- A. Heat Shrinkable Joint: Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.
- B. Cold Shrink Rubber Type Joint: Joint must be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket must be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice should be packaged three splices per kit, including complete installation instructions.

2.8 TELECOMMUNICATIONS CABLING (NOT USED)

2.9 LIVE END CAPS

Provide live end caps using a "kit" including a heat-shrinkable tube and a high dielectric strength, polymeric plug overlapping the conductor. Conform to applicable portions of IEEE 48.

2.10 TAPE

- A. Insulating Tape: UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 176 degrees F.
- B. Buried Warning and Identification Tape: Provide detectable tape in accordance with Section [31 00 00 EARTHWORK].
- C. Fireproofing Tape: Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than 0.030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.11 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.12 GROUNDING AND BONDING

- A. Driven Ground Rods: Provide [copper-clad steel ground rods conforming to UL 467] [solid copper ground rods conforming to UL 467] [solid stainless steel ground rods] not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.
- B. Grounding Conductors: Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

2.13 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.14 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478M ASTM C478. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable.

- A. Cast-In-Place Concrete: Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE. [Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.] [Concrete block must conform to ASTM C139 and Section 04 20 00, MASONRY.] [Concrete block is not allowed in areas subject to aircraft loading.]
- B. Precast Concrete Structures, Risers and Tops: Precast concrete underground structures may be provided in lieu of cast-in-place subject to the requirements specified below. Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.
 - 1. General: Precast concrete structures must have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures must have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction must be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work must have a 28-day compressive strength of not less than 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed, and produced by the manufacturer in accordance with the requirements specified. Structures must be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
 - 2. Design for Precast Structures: ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:
 - a. Angle of Internal Friction (ϕ) = 30 degrees
 - b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf
 - c. Coefficient of Lateral Earth Pressure (K_a) = 0.33
 - d. Ground Water Level = 3 feet below ground elevation
 - e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The

- minimum design vertical load must be for H20 highway loading per AASHTO HB-17.
3. Construction: Provide a uniform thickness for structure top, bottom, and wall not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the precaster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.
 4. Joints: Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to ASTM C990M ASTM C990. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.
- C. Manhole Frames and Covers: Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the top face of power and telecommunications manhole covers, respectively.
- D. Handhole Frames and Covers: Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Provide rolled-steel floor plate covers having an approved antislip surface. Hinges must be of [stainless steel with bronze hinge pin] [wrought steel], 5 by 5 inches by approximately 3/16 inch thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.
- E. Brick for Manhole Collar: Provide sewer and manhole brick conforming to ASTM C32, Grade MS.
- F. Composite/Fiberglass Handholes and Covers: ANSI/SCTE 77. Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass with a design load (Tier rating) appropriate for or greater than the intended use. All covers are required to have the Tier level rating embossed on the surface which must not exceed the design load of the box.

2.15 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

Zinc coat the metal portion of racks and arms after fabrication.

- A. Cable Rack Stanchions: The wall bracket or stanchion must be 4 inches by approximately 1-1/2 inch by 3/16-inch channel steel, or 4 inches by approximately 1 inch glass-reinforced nylon with recessed bolt mounting holes, 48 inches long (minimum) in manholes. Space slots for mounting cable rack arms at 8-inch intervals.
- B. Rack Arms: Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 8 inches and a maximum of 12 inches.
- C. Insulators: Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.16 CABLE TAGS IN MANHOLES

Provide polyethylene tags for each power cable located in manholes. Do not provide handwritten letters. The first position on the power cable tag denotes the voltage. The second through sixth positions on the tag identifies the circuit. The next to last position denotes the phase of the circuit and include the Greek "phi" symbol. The last position denotes the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

- A. Polyethylene Cable Tags: Provide tags of polyethylene having an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids,

alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag, having a minimum loop tensile strength of 175 pounds and black block letters, numbers, and symbols 1 inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.17 MEDIUM VOLTAGE ABOVE GROUND CABLE TERMINATING CABINETS

Cable terminating cabinets must be hook-stick operable, deadfront construction conforming to the requirements of IEEE C37.20.3, Category A. Provide cabinets with [200 A. loadbreak junctions and elbow-type separable loadbreak connectors, cable parking stands, and grounding lugs] [600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs]. Provide cable terminating equipment in conformance with IEEE 386.

2.18 LOW VOLTAGE ABOVE GROUND TERMINATION PEDESTAL

Provide copolymer polypropylene, low voltage above ground termination pedestal manufactured through an injection molding process. Pedestals must resist fertilizers, salt air environments and ultra-violet radiation. Pedestal top must be imprinted with a "WARNING" and "ELECTRIC" identification. Pedestal must contain [three][four] lay-in six port connectors, NEMA C119.4, Class "A", dual rated for aluminum or copper, and capable of terminating conductors ranging from 10 AWG to 500 kcmil. Protect each connector with a clear, hard lexan (plastic) cover. Provide pedestal with rust-free material and stainless-steel hardware that is lockable.

2.19 PROTECTIVE DEVICES AND COORDINATION (NOT USED)

2.20 SOURCE QUALITY CONTROL

- A. Arc-Proofing Test for Cable Fireproofing Tape: Manufacturer must test one sample assembly consisting of a straight lead tube 12 inches long with a 2 1/2 inch outside diameter, and a 1/8-inch-thick wall and covered with one-half lap layer of arc and fireproofing tape per manufacturer's instructions. The arc and fireproofing tape must withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. Direct the arc toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Test each sample assembly at three unrelated points. Start time for tests must be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time must be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape must indicate that the test has been performed and passed by the manufacturer.
- B. Medium Voltage Cable Qualification and Production Tests: Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

PART 3 – EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 [and IEEE C2] [and CALPUC G.O.128] as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644. [Treat soil a minimum 305 mm 12 inches on each side of the installed cable for the entire length in accordance with Section 313116 CHEMICAL TERMITE CONTROL.]

3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

Obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. [Prepare a checklist of significant requirements] [Perform pulling calculations and prepare a pulling plan] and submit along with the manufacturer's instructions in accordance with SUBMITTALS. Install cable strictly in accordance with the cable manufacturer's recommendations and the approved installation plan. [Calculations and pulling plan must include:

- A. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- B. List of cable installation equipment.
- C. Lubricant manufacturer's application instructions.
- D. Procedure for resealing cable ends to prevent moisture from entering cable.
- E. Cable pulling tension calculations of all cable pulls.
- F. Cable percentage conduit fill.
- G. Cable sidewall bearing pressure.
- H. Cable minimum bend radius and minimum diameter of pulling wheels used.
- I. Cable jam ratio.
- J. Maximum allowable pulling tension on each different type and size of conductor.
- K. Maximum allowable pulling tension on pulling device.]

3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Provide [PVC, Type EPC-40] [IMC] [RGS] conduit from the supply equipment to a point 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made. [Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.]

3.5 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors must have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound must conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Manhole locations, as indicated, are approximate. Coordinate exact manhole locations with other utilities and finished grading and paving.

- A. Cast-In-Place Concrete Structures: [Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.] [Provide concrete block conforming to ASTM C139 and Section 04 20 00 MASONRY.] [Concrete block is not allowed in areas subject to aircraft loading.]
- B. Precast Concrete Construction: Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer's instructions.
- C. Pulling-In Irons: Provide steel bars bent as indicated and cast in the walls and floors. Alternatively, pipe

sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor, locate the irons a minimum of 6 inches from the edge of the sump, and in the walls, locate the irons within 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 6-inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 3-foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into the structure of approximately 4 inches and must be designed to withstand a minimum pulling-in load of 6000 pounds. Hot dip galvanize irons after fabrication.

- D. Cable Racks, Arms, and Insulators: Cable racks, arms and insulators must be sufficient to accommodate the cables. Space racks in power manholes not more than 3 feet apart and provide each manhole wall with a minimum of two racks. Space racks in signal manholes not more than 16 1/2 inches apart with the end rack being no further than 12 inches from the adjacent wall. Methods of anchoring cable racks are as follows:
1. Provide a 5/8-inch diameter by 5-inch-long anchor bolt with 3-inch foot cast in structure wall with 2-inch protrusion of threaded portion of bolt into structure. Provide 5/8-inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.
 2. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel must be steel of the same length as "vertical rack channel;" and cast flush in structure wall. Provide 5/8-inch steel nuts in channel insert to receive 5/8-inch diameter by 3-inch-long steel, square head anchor bolts.
 3. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 800-pound load rating. Provide 5/8-inch diameter by 3-inch-long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.
- E. Field Painting: Clean cast-iron frames and covers not buried in concrete or masonry of mortar, rust, grease, dirt and other deleterious materials, and coat with bituminous paint.

3.6 DIRECT BURIAL CABLE SYSTEM

Direct-bury cables in the earth below the frostline [as indicated] [to the requirements of NFPA 70 and IEEE C2, whichever is more stringent].

- A. Trenching: Excavate trenches for direct-burial cables to provide a minimum cable cover of 24 inches below finished grade for power conductors operated at 600 volts or less, and 30 inches below finished grade for over 600 volts in accordance with IEEE C2. When rock is encountered, remove to a depth of at least 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Bottoms of trenches must be smooth and free of stones and sharp objects. Where materials in bottoms of trenches are other than sand, a 3-inch layer of sand must be laid first and compacted to approximate densities of surrounding firm soil. Trenches must be not less than [6][8] inches wide and must be in straight lines between cable markers. [Do not use cable plows.] Bends in trenches must have a radius [of not less than 36 inches] [consistent with the cable manufacturer's published minimum cable bending radius for the cable installed].
- B. Cable Installation: Unreel cables along the sides of or in trenches and carefully place on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position is not permitted, except as required to pull cables through conduits under paving or railroad tracks. Where two or more cables are laid parallel in the same trench, space cables laterally at not less than 3 inches apart, except that communication cable must be separated from power cable by a minimum distance of 12 inches. Where direct-burial cables cross under roads or other paving exceeding 5 feet in width, install such cables in [concrete-encased] ducts. Where direct-burial cables cross under railroad tracks, install such cables in [reinforced concrete-encased ducts] [ducts installed through rigid galvanized steel sleeves]. Extend ducts at

least 5 feet beyond each edge of any paving and at least 5 feet beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, center direct-burial cables in duct entrances, and a waterproof nonhardening mastic compound must be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Prevent damage to conduit coatings by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, restore the paving and subbase to their original condition. Where cable is placed in duct (e.g. under paved areas, roads, or railroads), slope ducts to drain.

- C. Splicing: Provide cables in one piece without splices between connections except where the distance exceeds the lengths in which cables are manufactured. [Where splices are required, install splices only in maintenance manholes/handholes or cabinets/pedestals.]
- D. Bends: Bends in cables must have an inner radius not less than those specified in NFPA 70 for the type of cable, or manufacturer's recommendation.
- E. Horizontal Slack: Leave approximately 3 feet of horizontal slack in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is brought above ground, leave additional slack to make necessary connections. [Enclose splices in lead-sheathed or armored cables in split-type cast-iron splice boxes; after completion of the connection, fill with insulating filler compound and tightly clamp the box.]
- F. Identification Slabs (or Markers): Provide a slab at each change of direction of cable, over the ends of ducts or conduits which are installed under paved areas and roadways [, over the ends of ducts or conduits stubbed out for future use] [, and over each splice]. Identification slabs must be concrete, approximately 20 inches square by 6 inches thick, set flat in the ground so that top surface projects not less than 3/4 inch, nor more than 1 1/4 inches above ground. Concrete must have a compressive strength of not less than 3000 psi and have a smooth troweled finish on exposed surface. Inscribe an identifying legend such as "electric cable," "telephone cable," "splice," or other applicable designation on the top surface of the slab before concrete hardens. Inscribe circuit identification symbols on slabs as indicated. Letters or figures must be approximately 2 inches high, and grooves must be approximately 1/4 inch in width and depth. Install slabs so that the side nearest the inscription on top includes an arrow indicating the side nearest the cable. Provide color, type and depth of warning tape as specified in Section [31 23 00.00 20 EXCAVATION AND FILL] [31 00 00 EARTHWORK].

3.7 UNDERGROUND CONDUIT AND DUCT SYSTEMS

- A. Requirements: Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 4/0 AWG bare copper grounding conductor [below][above] medium-voltage distribution duct banks. Bond bare copper grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of [3][4] inches per 100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Terminate all PVC conduit end points in utility holes, switching cabinets, transform handholes and buildings with end bells. The bell end of the conduits that enter manholes and handholes must be flush with the wall. Perform changes in ductbank direction as follows:
 - 1. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.
 - 2. The minimum manufactured bend radius must be 18 inches for ducts of less than 3-inch diameter, and 36 inches for ducts 3 inches or greater in diameter.
 - 3. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections allowed for use in field manufactured longsweep bend: 30 degrees.
- B. Treatment: Keep ducts clean of concrete, dirt, or foreign substances during construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer whenever an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before being laid. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

- C. Conduit Cleaning: As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.
- D. Jacking and Drilling Under Roads and Structures: Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, install rigid steel conduit because of its strength. To protect the corrosion-resistant conduit coating, predrilling, or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. [Hydraulic jet method must not be used.]
- E. Galvanized Conduit Concrete Penetrations: Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches from penetration).
- F. Multiple Conduits: Separate multiple conduits by a minimum distance of 3 inches [, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of [12] inches]. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.
- G. Conduit Plugs and Pull Rope: Provide new conduit indicated as being unused or empty with plugs on each end. Plugs must contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 915 mm 3 feet of slack at each end of unused or empty conduits.
- H. Conduit and Duct Without Concrete Encasement: Depths to top of the conduit must be not less than 24 inches below finished grade. Provide not less than 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4-inch sieve. The first 6-inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 3- to-6-inch layers. Provide color, type and depth of warning tape as specified in Section [31 23 00.00 20 EXCAVATION AND FILL] [31 00 00 EARTHWORK].
 - 1. Encasement Under Roads and Structures: Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3-inch concrete cover around ducts. Extend concrete encasement at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade [, and under railroad tracks not less than 50 inches below the top of the rails].
 - 2. Directional Boring: HDPE conduits must be installed below the frostline and as specified herein. [For distribution voltages greater than 1000 volts and less than 34,500 volts, depths to the top of the conduit must not be less than 1220 mm 48 inches in pavement-covered areas and not less than 3050 mm 120 inches in non-pavement-covered areas.] [For distribution voltages less than 1000 volts, depths to the top of the conduit must not be less than 1220 mm 48 inches in pavement- or non-pavement-covered areas.] [For branch circuit wiring less than 600 volts, depths to the top of the conduit must not be less than 610 mm 24 inches in pavement- or non-pavement-covered areas.]
- I. Duct Encased in Concrete: Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade [, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade]. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Before pouring concrete, anchor duct bank assemblies, prevent floating during concrete pouring by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. [Provide steel reinforcing in the concrete envelope as indicated.] [Provide color, type and depth of warning tape as specified in Section [31 00 00 EARTHWORK] [31 23

00.00 20 EXCAVATION AND FILL.]

1. Connections to Manholes: Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure must be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.
2. Connections to Existing Underground Structures: For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and [extend into] [bend out to tie into the reinforcing of] the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.
3. Connections to Existing Concrete Pads: For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and [extend into] [bend out to tie into the reinforcing of] the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.
4. Connections to Existing Ducts: Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks. [Remove existing cables which constitute interference with the work.] [Abandon in place those no longer used ducts and cables which do not interfere with the work.]
5. Partially Completed Duct Banks: During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 1 foot apart. Restrain reinforcing assembly from moving during concrete pouring.
6. Removal of Ducts: Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

- J. Duct Sealing: Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.8 CABLE PULLING

- A. [Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables.] Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with [tape][or][wire] shield must have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.
- B. Cable Lubricants: Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.9 CABLES IN UNDERGROUND STRUCTURES

- A. Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.
- B. Cable Tag Installation: Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.10 CONDUCTORS INSTALLED IN PARALLEL

- A. Group conductors such that each conduit of a parallel run contains one Phase A conductor, one Phase B conductor, one Phase C conductor, and one neutral conductor.

3.11 LOW VOLTAGE CABLE SPLICING AND TERMINATING

- A. Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. [Make splices in underground distribution systems only in accessible locations such as manholes, handholes, or aboveground termination pedestals.]
- B. Terminating Aluminum Conductors
 1. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors and use UL-listed solid aluminum connectors for connecting aluminum conductors. When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.
 2. Terminate aluminum conductors to copper bus either by: (1) in line splicing a copper pigtail to the aluminum conductor (copper pigtail must have a ampacity at least that of the aluminum conductor); or (2) using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers must be cadmium-plated hardened steel. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.
 3. Terminate aluminum conductors to aluminum bus by using all-aluminum nuts, bolts, washers, and lugs. Wire brush and apply inhibiting compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

3.12 MEDIUM VOLTAGE CABLE TERMINATIONS

- A. Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.13 MEDIUM VOLTAGE CABLE JOINTS

- A. Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.
- B. Joints in Shielded Cables: Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.
- C. Joints in Armored Cables: Enclose armored cable joints in compound-filled, cast-iron or alloy splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

3.14 CABLE END CAPS

- A. Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.15 LIVE END CAPS

- A. Provide live end caps for single conductor medium voltage cables where indicated.

3.16 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES
3.17 GROUNDING SYSTEMS

- A. NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][] ohms.
- B. Grounding Electrodes: Provide cone pointed driven ground rods driven full depth plus [150 mm 6 inches] [300 mm 12 inches], installed to provide an earth ground of the appropriate value for the particular equipment being grounded. If the specified ground resistance is not met, provide an additional ground rod in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.
- C. Grounding Connections: Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.
 - 1. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
 - 2. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.
- D. Grounding Conductors: Provide bare grounding conductors, except were installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG. [Provide direct connections to the grounding conductor with 600 v insulated, full-size conductor for each grounded neutral of each feeder circuit, which is spliced within the manhole.]
- E. Ground Cable Crossing Expansion Joints: Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.
- F. Manhole Grounding: Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.
- G. Fence Grounding: [Provide grounding for fences as indicated.] [Provide grounding for fences with a ground rod at each fixed gate post and at each corner post.] Drive ground rods until the top is 305 mm 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 305 mm 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Bond each gate section to its gatepost by a 1/8 by 1-inch flexible braided copper strap and ground post clamps. Clamps must be of the anti-electrolysis type.]
- H. Metal Splice Case Grounding: Ground metal splice cases for medium-voltage direct-burial cable by connection to a driven ground rod located within 600 mm 2 feet of each splice box using a grounding electrode conductor having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than No. 6 AWG.

3.18 EXCAVATING, BACKFILLING, AND COMPACTING

- A. Provide in accordance with NFPA 70 and Section 310000 EARTHWORK.
- B. Reconditioning Surfaces
 - 1. Unpaved Surfaces: Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct [or direct burial cable]. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface

with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Provide work in accordance with Section 329230 SEEDING.

2. Paving Repairs: Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, [restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.]

3.19 CAST-IN-PLACE CONCRETE

- A. Provide concrete in accordance with Section 033000 CAST-IN-PLACE CONCRETE.
- B. Concrete Slabs for Equipment: Unless otherwise indicated, the slab must be at least 200 mm 8 inches thick, reinforced with a 152 mm by 152 mm - MW19 by MW19 (6 by 6 - W2.9 by W2.9) 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Place slab on a 150 mm 6-inch thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 15 mm 1/2-inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment. Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.
- C. Sealing: When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.20 FIELD QUALITY CONTROL

- A. Performance of Field Acceptance Checks and Tests: Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.
 1. Medium Voltage Cables: Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.
 - a. Visual and Mechanical Inspection:
 - 1) Inspect exposed cable sections for physical damage.
 - 2) Verify that cable is supplied and connected in accordance with contract plans and specifications.
 - 3) Inspect for proper shield grounding, cable support, and cable termination.
 - 4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.
 - 5) Inspect for proper fireproofing.
 - 6) Visually inspect jacket and insulation condition.
 - 7) Inspect for proper phase identification and arrangement.
 - b. Electrical Tests
 - 1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.
 - 2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
5 kV	10kV rms (peak)
8 kV	13kV rms (peak)
15 kV	20kV rms (peak)

25 kV	31kV rms (peak)
35 kV	44kV rms (peak)

CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING	
5 kV	7kV rms (peak)
8 kV	10kV rms (peak)
15 kV	16kV rms (peak)
25 kV	23kV rms (peak)
35 kV	33kV rms (peak)

2. Low Voltage Cables, 600V: Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.
 - a. Visual and Mechanical Inspection
 - 1) Inspect exposed cable sections for physical damage.
 - 2) Verify that cable is supplied and connected in accordance with contract plans and specifications.
 - 3) Verify tightness of accessible bolted electrical connections.
 - 4) Inspect compression-applied connectors for correct cable match and indentation.
 - 5) Visually inspect jacket and insulation condition.
 - 6) Inspect for proper phase identification and arrangement.
 - b. Electrical Tests
 - 1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.
 - 2) Perform continuity tests to insure correct cable connection.
 3. Grounding System
 - a. Visual and Mechanical Inspection: Inspect ground system for compliance with contract plans and specifications.
 - b. Electrical Tests: Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test. Provide site diagram indicating location of test probes with associated distances and provide a plot of resistance vs. distance.
- B. Follow-Up Verification: Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

END OF SECTION 337102