National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

FAC-M5057

CONSTRUCTION SPECIFICATIONS

FOR

REVITALIZE BUILDING MECHANICAL SYSTEM (4755)

GEORGE C. MARSHALL SPACE FLIGHT CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MARSHALL SPACE FLIGHT CENTER, AL

Approval: _____ **Date:** 10/24/13
Lead, Facilities Engineering Office

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SECTION 010010 — SCOPE AND DESCRIPTION

PART 1 - GENERAL

1.1 SCOPE

A. The work to be performed under this project consists of providing the labor, equipment, and materials to perform the renovation of the office and high bay area HVAC and plumbing systems for building 4755. This effort shall include the following:
- replacement of aging air handlers,
- replacement of direct-expansion cooling with chilled water cooling,
- replacement of internally insulated ductwork with externally insulated ductwork,
- replacement of obsolete pneumatic controls and connection to UCS,
- renovation of piping,
- and removal of piping and equipment that will not be utilized in the new design.

1.2 DESCRIPTION

A. This request for proposal (RFP) is a bid-build (BB), full and open competition contract for construction. Building 4755 (Flight Hardware Development Facility) is classified as a Core Capability Facility and serves as the facility where flight hardware is manufactured and tested. It houses a manufacturing area, clean rooms, testing area, and offices.

B. Phasing and Building Operations:
1. HIGH BAYS NORTH AND SOUTH: The High-Bays areas will remain occupied and operational throughout this construction project.
2. THIRD AND FOURTH FLOORS: These floors shall be the first floors to have the mechanical systems revitalized. During this phase the first and second floors will remain occupied and operational.
3. FIRST AND SECOND FLOORS: During revitalization of these floors the third and fourth floors will be occupied and fully operational.
4. ELEVATOR ACCESS: The General contractor shall maintain safe access to the elevator throughout construction.
5. The COR will determine final phasing schedule after discussions with the user.

C. The following are the Additive Alternates for the Project:
1. <u>ADD ALTERNATIVE #1 -</u> Replace existing chilled and heating hot water piping with all new piping, except newly installed heating hot water runouts to high bay air handlers. If add alternate #1 is not selected, only piping branches to demolished equipment shall be demolished.
2. <u>ADD ALTERNATIVE #2 -</u> Replace all water closets, urinals, and selected lavatories as shown with new fixtures and replace all lavatory faucets. Remove all domestic hot water heaters and replace with a single unit located on the 4th floor. Remove all hot water piping and replace with new piping. Add a hot water re-circulation pump and associated hot water re-circulation piping.

1.3 APPLICABLE DOCUMENTS

A. The publications of the issues of referenced documents in effect on the date of issuance of invitation for bids form a part of this specification and, where referred to herein by basic designation only, are applicable to the extent indicated by the references thereto. In the event of difference between this specification or its accompanying drawings and the referenced document, this specification and its accompanying drawings shall govern to the extent of such difference.

1.4 CONTRACT DRAWINGS

A. The following drawings accompany this specification and are a part thereof. The Contractor shall check all drawings and specifications for construction interferences, detail misdescriptions, dimensional errors, and other conflicts and shall promptly notify the Contracting Officer of any discrepancies utilizing a “Request for Information.” The Contracting Officer shall make a written interpretation.

REF. NO.	SHEET TITLE	DRAWING NO.
G001	COVER SHEET & INDEX OF DRAWINGS	FAC-DA-4755-G001
A001	GENERAL NOTES & LEGEND	FAC-DA-4755-A001
A501	REFLECTED CEILING PLAN - FIRST FLOOR	FAC-DA-4755-A501
A502	REFLECTED CEILING PLAN - SECOND FLOOR	FAC-DA-4755-A502
A503	REFLECTED CEILING PLAN - THIRD FLOOR	FAC-DA-4755-A503
A504	REFLECTED CEILING PLAN - FOURTH FLOOR	FAC-DA-4755-A504
A601	RESTROOM PLAN ENLARGEMENTS	FAC-DA-4755-A601
M001	MECHANICAL GEN NOTES, ABBREVIATIONS & LEGEND	FAC-DA-4755-M001
M002	DEMOLITION PHOTOGRAPHS SERIES 1	FAC-DA-4755-M002
M003	DEMOLITION PHOTOGRAPHS SERIES 2	FAC-DA-4755-M003
M004	DEMOLITION PHOTOGRAPHS SERIES 3	FAC-DA-4755-M004
M005	DEMOLITION PHOTOGRAPHS SERIES 4	FAC-DA-4755-M005
M100	HVAC BASEMENT DEMOLITION PLAN	FAC-DA-4755-M100
M101	HVAC FIRST FLOOR DEMOLITION PLAN - AREA "A"	FAC-DA-4755-M101
M102	HVAC FIRST FLOOR DEMOLITION PLAN - AREA "B"	FAC-DA-4755-M102
M103	HVAC FIRST FLOOR DEMOLITION PLAN - AREA "C"	FAC-DA-4755-M103
M104	HVAC SECOND FLOOR DEMOLITION PLAN - AREA "B"	FAC-DA-4755-M104
M105	HVAC THIRD FLOOR DEMOLITION PLAN - AREA "B"	FAC-DA-4755-M105
M106	HVAC FOURTH FLOOR DEMOLITION PLAN - AREA "B"	FAC-DA-4755-M106
M200	HVAC BASEMENT NEW WORK DECTWORK PLAN	FAC-DA-4755-M200
M201	HVAC FIRST FLOOR NEW WORK DUCTWORK PLAN - AREA "A"	FAC-DA-4755-M201
M202	HVAC FIRST FLOOR NEW WORK DUCTWORK PLAN - AREA "B"	FAC-DA-4755-M202
M203	HVAC FIRST FLOORNEW WORK DUCTWORK PLAN - AREA "C"	FAC-DA-4755-M203
M204	HVAC SECOND FLOOR NEW WORK DUCTWORK PLAN - AREA "B"	FAC-DA-4755-M204

REF. NO.	SHEET TITLE	DRAWING NO.
M205	HVAC THIRD FLOOR NEW WORK DUCTWORK PLAN - AREA "B"	FAC-DA-4755-M205
M206	HVAC FOURTH FLOOR NEW WORK DUCTWORK PLAN - AREA "B"	FAC-DA-4755-M206
M300	HVAC BASEMENT NEW WORK PIPING PLAN	FAC-DA-4755-M300
M301	HVAC FIRST FLOOR NEW WORK PIPING PLAN - AREA "A"	FAC-DA-4755-M301
M302	HVAC FIRST FLOOR NEW WORK PIPING PLAN - AREA"B"	FAC-DA-4755-M302
M303	HVACFIRST FLOOR NEW WORK PIPING PLAN - AREA "C"	FAC-DA-4755-M303
M304	HVAC SECOND FLOOR NEW WORK PIPING PLAN - AREA "C"	FAC-DA-4755-M304
M305	HVAC THIRD FLOOR NEW WORK PIPING PLAN - AREA "B"	FAC-DA-4755-M305
M306	HVAC FOURTH FLOOR NEW WORK PIPING PLAN - AREA "B"	FAC-DA-4755-M306
M401	HVAC ENLARGED FIRST FLOOR MECHANICAL PLAN	FAC-DA-4755-M400
M501	HVAC DETAILS	FAC-DA-4755-M401
M502	HVAC DETAILS	FAC-DA-4755-M501
M601	MECHANICAL EQUIPMENT SCHEDULES	FAC-DA-4755-M601
M602	MECHANICAL EQUIPMENT SCHEDULES	FAC-DA-4755-M602
M701	MECHANICAL CONTROLS SEQUENCES	FAC-DA-4755-M701
M702	MECHANICAL CONTROLS SEQUENCES	FAC-DA-4755-M702
M703	MECHANICAL CONTROLS SEQUENCES	FAC-DA-4755-M703
M704	MECHANICAL CONTROLS CHILLED WATER SCHEMATIC	FAC-DA-4755-M704
M705	MECHANICAL CONTROLS HEATING HOW WATER SCHEMATIC	FAC-DA-4755-M705
M706	MECHANICAL CONTROLS SEQUENCES	FAC-DA-4755-M706
P001	PLUMBING GEN NOTES, ABBREVIATIONS, LEGEND & SCHEDULES	FAC-DA-4755-P001
P101	PLUMBING - FIRST FLOOR DEMOLITION PLAN - AREA "B"	FAC-DA-4755-P101
P102	PLUMBING - ADDITIONAL FLOORS DEMOLITION PLANS	FAC-DA-4755-P102
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P202	PLUMBING - ADDITIONAL FLOORS NEW WORK PLANS	FAC-DA-4755-P202
P301	PLUMBING - DETAILS	FAC-DA-4755-P301
E001	GENERAL NOTES & LEGEND	FAC-DA-4755-E001
E101	DEMO ELECTRICAL PLAN - 1ST FLOOR AREA A	FAC-DA-4755-E101
E102	DEMO ELECTRICAL PLAN - 1ST FLOOR AREA C	FAC-DA-4755-E102
E103	DEMO ELECTRICAL PLAN - 4TH FLOOR AREA B	FAC-DA-4755-E103
E201	ELECTRICAL PLAN - BASEMENT	FAC-DA-4755-E201
E202	ELECTRICAL PLAN - 1ST FLOOR AREA A	FAC-DA-4755-E202
E203	ELECTRICAL PLAN - 1ST FLOOR AREA B	FAC-DA-4755-E203
E204	ELECTRICAL PLAN - 1ST FLOOR AREA C	FAC-DA-4755-E204
E205	ELECTRICAL PLAN - 2ND FLOOR AREA B	FAC-DA-4755-E205
E206	ELECTRICAL PLAN - 3RD FLOOR AREA B	FAC-DA-4755-E206
E207	ELECTRICAL PLAN - 4TH FLOOR AREA B	FAC-DA-4755-E207
E301	SCHEDULES	FAC-DA-4755-E301
E401	ONE LINE DIAGRAM - SUBSTATION #2	FAC-DA-4755-E401

REF. NO.	SHEET TITLE	DRAWING NO.
E402	ONE LINE DIAGRAM - SUBSTATION #2 NEW WORK	FAC-DA-4755-E402
E403	ONE LINE DIAGRAM - SUBSTATION #3	FAC-DA-4755-E403
E404	ONE LINE DIAGRAM - SUBSTATION #3 NEW WORK	FAC-DA-4755-E404
E405	SUBSTATION ELEVATIONS	FAC-DA-4755-E405
UCS1	UCS GENERAL NOTES AND BLDG 4754 DEMO AND NEW PLAN	FAC-DA-4755-UCS1
UCS2	FIRST FLOOR UCS DEMO PLAN - AREA "A"	FAC-DA-4755-UCS2
UCS3	FIRST FLOOR UCS DEMO PLAN - AREA "B"	FAC-DA-4755-UCS3
UCS4	FIRST FLOOR UCS DEMO PLAN - AREA "C"	FAC-DA-4755-UCS4
UCS5	SECOND AND THIRD FLOOR UCS DEMO PLAN	FAC-DA-4755-UCS5
UCS6	FOURTH FLOOR UCS DEMO PLAN	FAC-DA-4755-UCS6
UCS7	BASEMENT AND ENLARGED ROOM 119/E-1 UCS DEMO PLAN	FAC-DA-4755-UCS7
UCS8	FIRST FLOOR UCS NEW WORK PLAN - AREA "A"	FAC-DA-4755-UCS8
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UCS10	FIRST FLOOR UCS NEW WORK PLAN - AREA "C"	FAC-DA-4755-UCS10
UCS11	SECOND FLOOR UCS NEW WORK PLAN	FAC-DA-4755-UCS11
UCS12	THIRD FLOOR UCS NEW WORK PLAN	FAC-DA-4755-UCS12
UCS13	FOURTH FLOOR UCS NEW WORK PLAN	FAC-DA-4755-UCS13
UCS14	BASEMENT AND ENLARGED ROOM 119/E-1 UCS NEW UCS PLAN	FAC-DA-4755-UCS14
UCS15	UCS FID01 DEMO SCHEDULE	FAC-DA-4755-UCS15
UCS16	UCS DEMO WIRING DETAILS	FAC-DA-4755-UCS16
UCS17	UCS DEMO WIRING DETAILS	FAC-DA-4755-UCS17
UCS18	UCS DEMO WIRING DETAILS	FAC-DA-4755-UCS18
UCS19	UCS DEMO WIRING DETAILS	FAC-DA-4755-UCS19
UCS20	UCS COMM TRUNK DEMO	FAC-DA-4755-UCS20
UCS21	UCS DEMO AND NEW NETWORK INFRASTRUCTURE	FAC-DA-4755-UCS21
UCS22	NEW UCS COMM TRUNK LAYOUT	FAC-DA-4755-UCS22
UCS23	NEW UCS COMM TRUNK LAYOUT	FAC-DA-4755-UCS23

REF. NO.	SHEET TITLE	DRAWING NO.
UCS24	UCS0001, CARDS 1-3 NEW WIRING DETAILS	FAC-DA-4755-UCS24
UCS25	UCS0001, CARD 4 NEW WIRING DETAILS	FAC-DA-4755-UCS25
UCS26	UCS0002, CARDS 1-3 NEW WIRING DETAILS	FAC-DA-4755-UCS26
UCS27	UCS0002, CARD 4 NEW WIRING DETAILS	FAC-DA-4755-UCS27
UCS28	UCS0003, CARDS 1-3 NEW WIRING DETAILS	FAC-DA-4755-UCS28
CS29	UCS0003, CARD 4 NEW WIRING DETAILS	FAC-DA-4755-UCS29
UCS30	UCS0004, CARDS 1-3 NEW WIRING DETAILS	FAC-DA-4755-UCS30
UCS31	UCS0004, CARD 4 NEW WIRING DETAILS	FAC-DA-4755-UCS31
UCS32	UCS0005 AND 4754-UCS0001 NEW WIRING DETAILS	FAC-DA-4755-UCS32
UCS33	UCS0006 AND UCS0007 NEW WIRING DETAILS	FAC-DA-4755-UCS33
UCS34	UCS SK'S	FAC-DA-4755-UCS34
UCS35	UCS SK'S	FAC-DA-4755-UCS35
UCS36	UCS SK'S	FAC-DA-4755-UCS36
UCS37	UCS SK'S	FAC-DA-4755-UCS37
UCS38	UCS SK'S	FAC-DA-4755-UCS38
UCS39	UCS SK'S	FAC-DA-4755-UCS39
UCS40	UCS VAV CROSS REFERENCE TABLE	FAC-DA-4755-UCS40

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 010010

SECTION 01 05 90 — SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 SUBMITTALS

The following shall be submitted in accordance with Section 013300, "Submittal Procedures," in sufficient detail to show full compliance with the specification.

A. Plan for maintaining roof watertight integrity.

B. List of Government-furnished property or equipment identifying the condition of and quantities as received.

C. Contractor’s e-mail address and emergency contact information, including cell phone numbers, home phone number and pager numbers for all key personnel and the business owner.

D. Traffic control plans.

E. Photographs of temporary structures to be brought on Center by the Contractor.

F. Notices for work above Federal Aviation Administration height limits.

G. UXO/CWM work/safety plan and certifications of UXO/CWM personnel.

1.2 CONTRACTOR’S WORKING DRAWINGS

A. It shall be the Contractor's responsibility to develop all necessary working drawings for installation of piping, ductwork, conduit, fixtures, and equipment. Design drawings are not intended to eliminate all dimensional conflicts in routing or location of piping, ductwork, conduit, fixtures, equipment, etc. but shall show only the general arrangement. Use of design drawings for working drawings will be at the Contractor's risk, and changes required in installed work due to failure of Contractor to develop working drawings shall be accomplished at no additional cost to the Government. Prefabricated items shall have working dimensions to accommodate the actual field dimension of earlier-installed items. The Contractor shall carefully investigate all structural, mechanical, electrical, architectural, and finish conditions affecting all his work and shall coordinate and resolve all dimensional conflicts.

1.3 COOPERATION WITH OTHERS

A. During the life of this contract it is anticipated that other contractors will be performing operations in the general area where work under this contract is being performed. The Contractor shall cooperate in all respects wherever necessary for the better prosecution of the work.

1.4 EXPLOSIVE AND DISPOSAL AREA PRECAUTION

A. The possibility exists that materials of unexploded ordnance (UXO) could be encountered on NASA/MSFC property. In most areas, the potential for these occurrences is small. However, if materials resembling and suspected to be UXO are discovered in a work area immediately stop all work, cordon off or barricade suspect area, withdraw from the area, contact the Fire Department at 911, the Contracting Officer, and the Facilities Maintenance Organization (FMO) COTR and inform them of the findings. Then, post temporary barriers to prevent personnel entry into the area and remain near the site at a safe distance from the suspected UXO until the Contracting Officer or COTR takes charge of this activity. The Contracting Officer or COTR will then arrange for investigation and safe disposal of suspect material. Upon clearance from the Contracting Officer or COTR, work may then be resumed in the area.

B. Some areas are known to have formerly been utilized for ordnance related manufacturing, delivery, storage, and/or disposal activities. These areas are identified on the "Army and NASA Site Access Control Boundaries" map. When work is to be accomplished in the areas designated on the map as "Facilities Precautionary UXO Area" or as "UXO/CWM Probability 'Occasional', 'Remote', or 'Seldom'", prior to beginning construction, contractor shall procure the services of a UXO services provider (qualified for the project-specific requirements as shown on the drawings) for initial investigation and characterization, and then a remediation recommendation, required when suspect material is detected. Upon receipt of a report that states potential UXO was detected during investigation, the Contracting Officer or COTR will then arrange for disposition of suspect material. UXO services provider shall employ personnel with skills that meet applicable minimum qualification requirements contained in the U.S. Army Corps of Engineers document, "Attachment to Chapter 20, EP 1110-1-18, Ordnance and Explosives Response, UXO Personnel Training and Experience Hierarchy", at the end of this Section. UXO services provider shall submit for approval documentation that includes the number and names of employees to be utilized for the effort and their corresponding levels of training and experience, including copies of certifications and/or other qualifying paperwork. Additionally, UXO services provider shall have a work plan and a safety plan approved by NASA MSFC prior to initiating job activities. Alternately, when working under a prime contractor, UXO investigation work and safety plan requirements may be included in the prime contractor's work and safety plans. Questions concerning UXO operations and work plans may be addressed to the Contracting Officer or the COTR. Prior to commencing UXO investigation that requires disturbing the soil, obtain a digging permit from the Contracting Officer or the COTR.

C. The Contractor shall be responsible for alerting personnel under his authority, including subcontractor personnel, when the site of work is located on a site known to have had former ordnance activity.

D. The "Army and NASA Site Access Control Boundaries" map, showing the areas at MSFC which have the potential to contain UXO, is available for reference. Contact the Contracting Officer or COTR to obtain this information.

1.5 CHEMICAL WARFARE MATERIAL PRECAUTION

A. The possibility exists that chemical warfare material (CWM) could be encountered on NASA/MSFC property. In most areas, the potential for these occurrences is small. However, if such materials are suspected in a work area, immediately stop all work, cordon off or barricade suspect area, withdraw from the area, contact the Fire Department at 911, the Contracting Officer, and the FMO COTR, and inform them of the findings. Then, remain near the site at a

safe distance from the suspected CWM, and post temporary barriers to prevent personnel entry into the area until the Contracting Officer or COTR takes charge of this activity. The Contracting Officer or COTR will then arrange for investigation and safe disposal of suspect material. Upon clearance from the Contracting Officer or COTR, work may then be resumed in the area.

B. Some areas are known to have formerly been utilized for chemical warfare related manufacturing, delivery, storage, and/or disposal activities. These areas are identified on the "Army and NASA Site Access Control Boundaries" map. When work is to be accomplished in the areas designated on the map as "UXO/CWM Probability 'Occasional', 'Remote', or 'Seldom'", prior to beginning construction, contractor shall procure the services of a CWM services provider (qualified for the project-specific requirements as shown on the drawings) for initial investigation and characterization, and then a remediation recommendation, required when suspect material is detected. Upon receipt of a report that states potential CWM was detected during investigation, the Contracting Officer or COTR will then arrange for disposition of suspect material. CWM services provider shall meet applicable minimum qualification requirements for the work to be performed. CWM services provider shall submit for approval documentation that includes the number and names of employees to be utilized for the effort and their corresponding levels of training and experience, including copies of certifications and/or other qualifying paperwork. Additionally, CWM provider shall have a work plan and a safety plan approved by NASA MSFC prior to initiating job activities. Alternately, when working under a prime contractor, CWM work and safety plan requirements may be included in the prime contractor's work and safety plans. Questions concerning CWM operations and work plans may be addressed to the Contracting Officer or COTR. Prior to commencing CWM investigation that requires disturbing the soil, obtain a digging permit from the Contracting Officer or COTR.

C. The Contractor shall be responsible for alerting personnel, including subcontractor personnel, when the site of work is located on a site known to have had former CWM activity.

D. The "Army and NASA Site Access Control Boundaries" map, showing the areas at MSFC which have the potential to contain CWM, is available for reference. Contact the Contracting Officer or COTR to obtain this information.

1.6 SECURITY

A. The Contractor shall conform to security procedures as directed by the Contracting Officer. Additional information will be provided at the preconstruction meeting and as changes occur during the contract period. Status of Center access is available by calling (256)544-HELP.

B. Center Entry and Vehicles: Entry security at the Center is critical to effect a safe environment. All personnel, vehicles, equipment, and materials are subject to search, investigation, and authorization at each entry and while on Center. Construction vehicles and trucks delivering large equipment and materials, including concrete trucks, shall enter the Center via Gate 1 or 10 or as directed by the Contracting Officer. Significant entry delays should be expected, particularly at higher security levels, so the Contractor is responsible for keeping himself apprised of security conditions and entry requirements at the Center and notifying his contract personnel of changes in order to prosecute contract work in a timely manner without delay. All vehicles must have proof of valid registration and insurance residing in the vehicle at all times

and shall show such proof to security personnel on demand and in order to obtain a vehicle pass.

C. Personnel Identification and Badging: All personnel shall be able to show proof of United States citizenship and have on their person, valid Government-issued picture identification such as a driver's license. All Contractor personnel, including subcontractor and visitor personnel, shall have and display on their person a badge issued by Center security at all times. Center security has the right to not issue, confiscate, or change any badge. The Contractor is responsible for assuring each individual working under this contract is immediately badged in the first instance, continually wears and displays a valid badge, has only the necessary access permissions, and returns the badge to Center security upon completion of their work just prior to leaving the Center. All personnel requiring access to the Center by the Contractor shall possess either a visitor's badge or picture badge issued by Center security at Building 4312. All Contractor personnel requiring access to the east or west test areas must receive test area access training provided by MSFC.

D. Any person on Center failing to have in their possession a valid badge or operating a vehicle without a valid pass is ultimately subject to arrest and further legal action.

1.7 SPECIAL CONSIDERATIONS FOR SPECIAL HOURS OF WORK

A. Reference contract Section H attached to Standard Form 1442 – "Solicitation, Offer, and Award" – regarding "Hours of Work" therein. The following are clarifications and additional requirements necessary to perform work at the Marshall Space Flight Center (MSFC).

1. "Duty Hours" shall be considered to be 7:00 a.m. to 5:00 p.m., Monday through Friday, excluding Government holidays. All other times shall be considered "Non-Duty Hours."

2. The Contractor shall only schedule and plan contract performance during "Duty Hours,", unless specific allowances are made elsewhere herein for specific activities that may be required to be performed during "Non-Duty Hours."

3. The Contractor shall make all requests to work during "Non-Duty Hours" by 9 AM of the day before the requested work period begins. The Contracting Officer must approve any work activities during "Non-Duty Hours" prior to the start of work for the period requested." These requests will typically be denied unless justifiable by outages, road crossings, hazardous operations, coordination with Government operations, and/or facility or subsystem need date.

4. All items above as well as all other Special Conditions of Section 010590 shall be factored into the Contractor's scheduling of work to meet the contract's performance period at no additional cost to the Government after contract award.

5. The Contractor may be prohibited from working in the east and west test areas approximately two days per week during hazardous testing operations. The Government typically issues a tentative weekly schedule on the Friday preceding a week which has scheduled testing. The Contractor is responsible for monitoring this schedule, making regular contact with the test point of contact, closely coordinating their specific activities, and adjusting/delaying construction activities to accommodate testing operations without additional cost to the Government after contract award.

1.8 TEMPORARY UTILITIES

A. Contractor shall provide temporary utilities required for construction. Materials may be new or used, shall be adequate for the required usage, shall not create unsafe conditions, and shall not violate applicable codes and standards.

B. Water: All reasonably required amounts of water will be available to the Contractor by the Government from such existing water systems, outlets, and supplies, without cost to the Contractor for the water he consumes. The Contractor shall be responsible for approved disposal of wastewater. The Contractor shall install and maintain at his own expense any necessary supply connections, safety measures, and facilities in a workmanlike manner as approved by the Contracting Officer. All water shall be carefully conserved. Before final acceptance, temporary connections and piping installed by the Contractor shall be removed in a manner satisfactory to the Contracting Officer.

C. Electricity: Electric power will be made available to the Contractor by the Government in the form of single phase 208V/120V or 240V/120V, depending on availability, 60 Hz, 100A service without cost to the Contractor for temporary power purposes. Other electrical service may be provided, if available and accessible to the construction site, upon request by the Contractor and approved by the Contracting Officer. The Contractor shall install and maintain at his own expense any necessary supply connections, safety measures as required by 29 CFR 1926 Subpart K, 1926-402-408 or NEC ANSI/NFPA 70 plus formal interpretations and tentative interim amendments, and facilities in a workmanlike manner as approved by the Contracting Officer. All electricity shall be carefully conserved. When Government-provided temporary power is not available, is not of sufficient capacity, or is not of sufficient power quality, the Contractor is responsible for providing his own temporary power at his own expense. The Contractor is responsible for protecting his own electrical equipment and devices as necessary at his own expense from damage due to electrical events such as lightning, loss of power, power surges and sags, single phasing, and poor power quality.

D. Compressed Air: The Contractor is responsible for providing compressed air as needed at his own expense.

E. Breathing Air: The Contractor is responsible for providing breathing air as needed at his own expense.

F. Telephone Service: Contractor shall provide his own telephone service at his own expense.

G. Sanitary Facilities: Contractor shall provide temporary sanitary facilities in accordance with 29 CFR 1926.51 and shall service, clean, and maintain these facilities and enclosures at least once per week. Temporary facilities shall be removed from the site at the completion of the work. Sanitary facilities in existing facilities are unavailable for Contractor use.

H. Removal of Temporary Utilities: Before final project acceptance, temporary connections and facilities installed by the Contractor shall be removed and all removal locations painted, graded, etc. as necessary to match surrounding conditions in a workmanlike manner and hazard-free condition to the satisfaction of the Contracting Officer.

1.9 TRAFFIC PROVISIONS

A. Maintenance of Traffic: Contractor shall conduct his operations in a manner that will not close any thoroughfare or interfere in any way with traffic on roadways except with written permission of the Contracting Officer. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met. Work shall be conducted so as to minimize obstruction of traffic, and traffic shall be maintained on at least half of the roadway width at all times. If the entire roadway width requires blocking, the Contractor shall submit a traffic control plan to the Contracting Officer's Technical Representative for approval prior to blocking the roadway. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic in any manner (one half of the roadway or the entire width of the roadway). Contractor shall provide, erect, and maintain, at his own expense, lights, barriers, signals, passageways, detours, etc., that may be required.

B. Rush Hour Restrictions: Contractor shall not interfere with the peak traffic flows preceding and during normal operations without notification to and approval by the Contracting Officer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION OF FACILITIES, MATERIAL, AND WORK

A. The Contractor shall at all times protect and preserve all facilities, materials, supplies, and equipment of every description (including property which may be Government-furnished or owned) and all work performed. All reasonable requests of the Contracting Officer to enclose or especially protect such property shall be complied with. If, as determined by the Contracting Officer, material, equipment, supplies and work performed are not adequately protected by the Contractor such property may be protected by the Government and the cost thereof may be charged to the Contractor or deducted from any payments due him.

3.2 PROTECTION OF UNDERGROUND UTILITIES/DIGGING PERMITS

A. Prior to performing any excavation work or any surface penetrations 6 inches or deeper (such as driving stakes more than 6 inches in the ground) on any ground surface, this includes both outside and inside of buildings, structures, tents, or gazebos, etc., the Contractor shall obtain from the Facilities Office a digging permit and the current subsurface utility drawing of the particular area to be worked on. Subsurface excavations include the penetration of ground below slabs on grade or interior building slabs that are in contact with the ground. Requests for dig permits shall be made a minimum of two working days prior to conducting any planned digging or excavation activities. Contractor shall stake out subsurface high voltage cables, communication cables, and pipelines indicated within the scope of the work contemplated. After exposure, the Contractor shall obtain agreement from the Contracting Officer on how much closer to cable or pipe the excavations can be permitted. Contractor shall notify the Contracting Officer, 48 hours prior to the start of excavation work or surface penetration, to enable the Contracting Officer to review measures being taken to prevent hazard to employees and possible damage to subsurface utilities. Where emergency conditions preclude the 48 hours advance notification, the Contractor shall immediately inform

the Contracting Officer. After obtaining clearance from the Contracting Officer, the Contractor shall proceed with excavating work, or other surface penetration work. Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 3 feet of the staked-out cable or pipeline until the Contractor has exposed the cable or pipe by hand excavation to fix its location.

B. Trenching machines and augers shall not be used unless approved in advance by the Contracting Officer.

C. Prior to commencing any operations which include digging, excavations, or soil borings, etc. where there is considerable doubt of the location of concealed utilities, the Contractor shall de-energize or turn off all hazardous utilities to the building and surrounding areas.

D. When de-energizing is not possible, a waiver shall be required to allow work to continue. The waiver shall provide rationale detailing how the safety of the workers will be maintained. The waiver shall be approved by the Facilities Management Office project manager and the MSFC Industrial Safety Office.

3.3 LAYOUT OF WORK

A. The Contractor shall lay out his work from the Government-established base lines and bench marks and shall be responsible for all measurements in connection therewith. The Contractor shall furnish, at his own expense, all stakes, templates, equipment, range markers, and labor as may be required in laying out any part of the work from the base lines and bench marks established by the Government. The Contractor will be held responsible for the execution of the work to such lines and grades as may be established or indicated by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through his negligence prior to their authorized removal, they may be replaced by the Contracting Officer at his discretion. The expense of replacement will be deducted from any amount due, or to become due, the Contractor.

3.4 TEMPORARY STRUCTURES AND LAYDOWN AREA

A. All temporary structures and equipment such as construction office trailers, storage trailers, boom trucks, dump trucks, backhoes, etc. are to be in good and fully operable condition, with no broken windows, rusted areas, boarded-up openings, loose insulation, bent doors, paint in poor condition, leaks, exposed wiring, code or safety violations, or other similar defects when brought on site and are to be maintained in good and fully operable condition while they are on site. Contractor shall submit photographs of all trailers, storage units, or other temporary structures and equipment for review and initial approval prior to bringing them on Center. Regardless, trailers and equipment are to be inspected for final approval for lay down by the Government when they are brought on site prior to detaching them from the truck that delivers them so they can be immediately removed if they are found to be in unacceptable condition.

B. At least 7 days prior to arrival, the Contractor shall request the need for and extent of an all-inclusive lay down area for temporary structures, equipment, material, vehicle parking, fencing, fence gates, hazardous material storage, and the like for the duration of the work. The lay down area shall be marked up in detail on the site plan drawing and submitted for approval by the Government. Once approved, all office trailers shall be installed per the International

Building Code, the Alabama Manufactured Housing Commission, and NASA safety requirements, whichever is most stringent. Any type of structure used in whole or part as office space or otherwise occupied on a regular basis shall be tied down. Utility connections shall be installed according to applicable codes/standards and in a neat and acceptable manner.

C. Housekeeping in the structures and about the lay down area shall be very well kept on a daily basis and the grass, weeds, and the like shall be kept below 6 inches in height at all times; all other areas within the construction site boundaries shall be kept below 12 inches in height. Open storage of material both singularly and collectively shall be kept and in a manner continuously acceptable to the Government.

D. Only equipment and material necessary for the work shall be kept on site, and equipment shall not be repaired on site without prior approval from the Government for more than very minor repairs.

E. All structures and equipment requiring certification, licensure, etc. shall be kept current at all times or immediately removed from the Center. Any changes to the lay down area use, arrangement, boundaries, or egress must be pre-approved by the Government.

3.5 NASA MISSION NON-INTERFERENCE

A. The Center conducts special tests and experiments, as well as unique operations that cannot be interrupted. Certain operations such as Space Shuttle flights have predetermined periods of non-interference where the Contractor can plan ahead with little or no impact to the project Schedule. During such flights, a Dig Moratorium will be issued where the Contractor cannot dig more than 6 inches below the surface.

B. Other non-interferences are utility related and require extensive coordination and precise planning and timing.

C. Non-interference periods shall be shown on the project Schedule to the extent they potentially impact the project Schedule.

3.6 INTERRUPTION OF UTILITIES

A. Interruption to utility services, such as (but not limited to) water, sanitary sewer, steam, electricity, communications, air, high-pressure systems, heating, and air conditioning systems, shall occur at such times as permitted by the Contracting Officer so that interruption of such services will not interfere with the operation of the Center. Generally, such outages to utility services shall be scheduled in advance and caused by the Contractor on Saturdays, Sundays, or other nonworking days or periods at no additional cost to the Government. The existing steam distribution system shall not be altered nor service to existing buildings be interrupted without prior written approval of the Contracting Officer. Such interruption to the steam distribution system insofar as is practicable shall be accomplished in the summer season. All interruptions shall be held to the minimum practicable. Interruption to high-pressure systems must be pre-planned 90 days in advance, with date certain and duration certain.

B. Notice of Interruptions: The Contractor shall submit each and every request for each individual utility outage in writing seven calendar days in advance of the actual need date for

approval by the Contracting Officer. Each required interruption anticipated by the Contractor shall be indicated on the project Schedule for pre-planning purposes by the Government to support the work; lack of such indication, or lack of date accuracy where the date changes from the previously approved project Schedule may result in delays and any such delay will be at the sole expense of the Contractor.

3.7 LEAKAGE PREVENTION

A. Capping of Piping Systems: All piping installed by the Contractor that is connected to a pressurized piping system, and not connected immediately to equipment, shall be terminated with a properly rated cap, blind flange, or capped valve and not left open-ended when Contractor personnel are not at the jobsite.

B. Construction Surveillance: At such time when new or modified piping systems are activated, the Contractor shall provide adequate personnel to monitor the initial start-up and operation of that system to insure that no damaging leak occurs. A monitor shall be present at each separate site of piping installation or modification at the instant of system activation. These Contractor personnel shall be authorized to immediately deactivate the system and qualified to make emergency repairs in the event of system failures. The Contractor shall notify Contracting Officer's Technical Representative a minimum of 2 days prior to activation.

3.8 GOVERNMENT FURNISHED PROPERTY

A. - The design drawings will indicate the government furnished property to be incorporated or installed in the work or used in its performance. Salvage property to be removed and reused that is in the general work area shall be handled as a Contractor Service and not listed here.

B. Property shall be furnished on the ground at a location within the MSFC boundaries as designated by the Contracting Officer. The Contractor shall be responsible for paying any demurrage or detention charges incurred loading, unloading, and transporting the property to the job site at his own expense.

C. All such property shall be installed or incorporated into the work at the expense of the Contractor, unless otherwise indicated herein.

D. The Contractor in conjunction with an authorized Government representative shall verify the quantity and condition of such Government-furnished property when delivered to him, acknowledge receipt thereof in writing to the Contracting Officer, and in case of damage to or shortage/overage of such property, he shall within 24 hours report in writing such damage or shortage/overage to the Contracting Officer.

E. It is the intention of the Government to furnish all of these items required to complete the work as specified and the various quantities will be adjusted when necessary. These quantities are not to be considered as indications or warranties that the amounts stated will either be sufficient or insufficient. The Contractor shall be required to furnish any additional quantities required.

3.9 SALVAGE MATERIALS AND EQUIPMENT

A. The Contractor shall maintain adequate property control records for all materials or equipment specified to be salvaged. These records may be in accordance with the Contractor's system of property control, if approved by the Contracting Officer. The Contractor shall be responsible for the adequate storage and protection of all salvaged materials and equipment and shall replace, at no cost to the Government, all salvage materials and equipment broken or damaged during salvage operations as the result of his negligence, or while in his care. Any salvaged materials and equipment that are excess upon the completion of the work shall remain the property of the Government. All such excess material and equipment shall be loaded, transported, and unloaded by the Contractor in a location specified by the Contracting Officer within the boundaries of the Marshall Space Flight Center.

3.10 CONSTRUCTION PROCEDURES

A. The Contractor shall use the following procedures and methods. Only the most current Government approved forms shall be used.

B. Request for Information (RFI) S.O.P. 7321.6: The purpose of this procedure establishes the system for initiating, dispositioning the clarification of technical or quality assurance requirements specified in the contract documents, and engineering direction to the Contractor for no-cost changes to the specifications or drawings.

C. Design Change Requests (DCR's) S.O.P. 7321.1: The purpose of this procedure establishes the system for documenting and approving changes to the contract documents if on-site work must be performed prior to the contract modifications.

D. Construction Deficiency Reports (CDR's) S.O.P. 7321.3: The purpose of this procedure establishes the system for initiating, processing, distributing, and controlling any item, condition, or material which deviates from engineering drawings, specifications, or procedures which require a disposition from NASA Engineering to resolve.

E. Quality Verification System (QVS) S.O.P. 7321.2: The purpose of this procedure is to plan and perform inspections, tests, and reviews to determine compliance with engineering and quality requirements or procedural methods for data gathering. It provides for planning of activities, establishment of hold points, and documentation of the performance and results of the verification.

F. Preparation, Review, Approval & Control of Submittals S.O.P. 7321.8: The purpose of this procedure establishes the system for initiating, approving, and controlling submittal documents.

G. Field Drawing Changes (FDC) S.O.P. 7321.5: The purpose of this procedure is to establish a method of resolving and documenting same-day, no-cost field adjustments by the COTR.

3.11 ELECTRONIC CAPABILITY

A. The Contractor shall have in-house computer capability to perform daily electronic mail, word processing, Internet connectivity, virus protection, and project scheduling.

B. Contractor management and administration personnel shall be competent in the electronic capability and able to create, print, save, and electronically transfer documents, files, and messages.

C. The Contractor's site superintendent shall have an active cell phone in his possession at all times for emergency and Government representative communication.

D. The Contractor shall submit his e-mail address and emergency contact information, including cell phone numbers, home phone numbers, and pager numbers, for all key personnel as well as the business owner.

3.12 COMMUNICATION RADIOS

A. To insure safety to Government personnel on nearby test stands and to prevent dangerous radio interference from damaging space vehicle test programs underway near site, the Contractor shall not use any radio communication on or near site without coordinating same with Contracting Officer. Radio use is also restricted in certain laboratories, operation centers, and communication and computer rooms as directed by signage and the Contracting Officer. All frequencies used must be submitted for approval by the Contracting Officer prior to use.

3.13 HOUSEKEEPING

A. The Contractor shall comply with the requirements of 29 CFR 1926.25 and assure cleanliness of facilities, equipment, and protection against damage before, during, and after installation. Generally, all working and storage areas will be cleaned regularly. The Contractor shall maintain such conditions insofar as good working practices will permit. It is essential to the proper conduct of the work and to the safety of workers and others that good housekeeping be practiced at all times. Equipment shall be kept clean and shall be protected against damage before, during, and after installation. All working and storage areas shall be cleaned regularly and all scrap materials and refuse properly and promptly disposed of. Accumulations of such materials and, in particular, accumulations of flammable crates, packing, plastic coverings, and other scrap materials in working or storage areas will not be tolerated. All areas shall be left neat, clean, and free from obstructions and hazards at the end of each working day or shift.

3.14 WEATHERTIGHT INTEGRITY OF BUILDING DURING CONSTRUCTION PERIOD

A. Contractor shall not remove or penetrate any portion of the roof that he cannot replace with the specified roofing system by the end of the workday or protect by other approved methods in the event of rain or other inclement weather that might occur during the workday. The connection of the installed specified roofing system to an existing roofing system shall be made watertight at the end of each workday and/or in the event of inclement weather that might occur during the workday. The details for said connection and the manner that the Contractor plans to maintain a watertight roof throughout the entire period of performance shall be submitted for review and approval by the Contracting Officer's Technical Representative; this shall be approved before work can commence. For 24 hours a day, 7 days per week, throughout the period of the contract, the Contractor will be responsible for keeping moisture outside of the building interior.

B. In the event that there is water penetration, the Contractor shall take immediate action to provide all materials, equipment, and labor to capture the moisture, dispose of the moisture, and protect all contents of the building.

C. The Contractor shall make repairs to stop any water penetration in a timely manner. The Contracting Officer reserves the right to stop the work when he determines the Contractor is not executing the work in a responsible manner and is causing any water penetration of the building. Work will resume once the Contractor has shown evidence that he has prepared an adequate plan for the remainder of the work; said plan shall include preventive measures to assure watertight conditions throughout the remainder of the contract.

D. When the Contractor fails to respond in time to prevent damage from occurring, MSFC maintenance personnel will respond to clean up and protect as best possible until Contractor personnel arrive. Costs incurred by the Government and maintenance operations associated with such response shall be deducted from any of the Contractor's pay requests and the contract value reduced accordingly by the Contracting Officer.

E. When the Contractor fails to adequately protect equipment and materials, the Contractor shall pay all expenses to replace or repair any and all damages and in a manner acceptable to the Contracting Officer. Such payments shall be made within 30 days of invoice date, and proof of such payments shall be submitted to the Contracting Officer within 15 days of payment date.

3.15 CONSTRUCTION SITE DUST AND MUD CONTROL

A. The Contractor is responsible for establishing effective and mandatory controls to prevent dust and mud from leaving the construction site boundary. These controls shall be communicated to all personnel and enforced at all times. All resulting additional environmental controls required shall be in place, functional, and inspected daily.

B. The Contractor is responsible for preventing wind-blown dust from going outside the construction site boundary including civil works during normal business hours and during other hours the Contractor is present on the site.

C. The Contractor is responsible for preventing vehicles from tracking and depositing mud and other similar debris and materials outside the construction site boundary. Any such tracking or depositing on roadways, parking lots, sidewalks, equipment, building walls, and any other man-made surface shall be cleaned up immediately without delays to the satisfaction of the Contracting Officer. Rainfall is not an acceptable method.

D. The Contractor shall provide at his expense all the necessary labor, equipment, and material.

3.16 CONSERVATION

A. All energy consumption and resources shall be conserved to the greatest extent possible by the Contractor. The Contractor is responsible for communicating this requirement to all on-site personnel and for compliance. Energy and resource utilization shall be proactively managed and conservation measures and methods developed and promoted by the Contractor's management and supervision.

B. Temporary lighting shall be divided into switchable areas of relatively small size to promote and achieve energy conservation to the satisfaction of the Government. Lighting shall be off unless absolutely necessary to accomplish the work at hand. Lighting for security purposes only shall be minimized and other non-energy consuming methods employed to the greatest extent.

C. Recyclable materials (e.g. aluminum cans, white paper, cardboard, metals, etc.) shall be diverted from the waste stream and delivered to the appropriate off-site, off-Center recycle center by the Contractor as indicated. For Leadership in Energy and Environmental Design (LEED) projects, see other specification sections for more stringent requirements.

D. All cardboard materials shall be flattened, consolidated, and recycled. Cardboard may be delivered to the Center's cardboard recycling location.

3.17 FEDERAL AVIATION ADMINISTRATION (FAA) REQUIREMENTS

A. The Contractor shall comply with all applicable FAA regulations, particularly FAA AC 70/7460-1.

B. The Contractor shall provide all notices to the COTR in writing in order for the Government to assist the Contractor in meeting the applicable FAA regulations. The FAA requires multiple notifications and submission of forms then approval for any work including cranes above the ground over a certain height from ground level at the construction site (height limit). The Contractor shall know the current regulations and provide the notifications to meet these regulations using the 100 to 1 slope from the Redstone Army Airfield. The Contractor shall determine the requirements and any potential project impacts (both schedule and cost) prior to bidding. The Contractor shall assist the Government in completing all required forms and provide all the necessary information for accurate form completion.

C. The Contractor shall notify the COTR in writing as follows to facilitate timely form completion and submission:

1. 35 calendar days prior to anticipated breach of height limit;
2. 72 hours prior to actual breach of height limit;
3. The same day when the construction or alteration of the structure reaches its greatest height;
4. Any supplemental notices required by the FAA or the Contracting Officer.

D. Aviation lighting shall be provided by the Contractor at his own expense as indicated on the approved FAA forms but will be as typically defined under the TEMPORARY UTILITIES paragraph herein. Contractor shall typically provide a minimum of 2 aviation lights of red or high intensity white obstruction lights on temporary structures (including cranes) over the "height limit" determined by the FAA Requirements. Lights shall be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer or FAA

3.18 TRENCHING/EXCAVATIONS

A. Prior to beginning any excavations, this includes both outside and inside of buildings, structures, tents, or gazebos, etc., an excavation permit shall be obtained from the FMO.

Trenching machines and augers shall not be used unless approved in advance by the COTR and it shall be so annotated on the issued excavation permit. Before starting any earth work, the location of underground utilities shall be carefully verified. Utilities to be left in place shall be protected from damage. Trench excavations over 5 feet in depth shall be shored braced or sloped to the angle of repose of the material. Excavated or other materials shall be shored and retained at least 2 feet from the edge of the excavation to prevent it from falling or sliding back into the excavated area and to prevent excessive pressure upon the side of the excavation.

B. Excavations, trenching and shoring requirements for the protection of employees in OSHA Regulation, CFR 29 part 1926.650 shall be employed and enforced. Side and slopes of excavations shall be maintained in a safe condition by scaling, benching or barricading. Where employees are required to be in trenches, a ladder extending from the floor of trench/excavation to at least 3 feet above top of excavation, located as to provide means of exit without more than 25 feet of lateral travel. Excavations will be barricaded and posted with warning signs for the safety of personnel. Warning lights will be provided during hours of darkness.

C. The Contractor shall ensure employees working in or around excavation projects are trained and familiar with the safety requirements in 29 CFR 1926. 650 – 652 (Subpart P).

D. Prior to commencing any operations which include digging, excavations, or soil borings, etc. where there is considerable doubt of the location of concealed utilities, the Contractor shall de-energize or turn off all hazardous utilities to the building and surrounding areas.

E. When de-energizing is not possible, a waiver shall be required to allow work to continue. The waiver shall provide rationale detailing how the safety of the workers will be maintained. The waiver shall be approved by the Facilities Management Office project manager and the MSFC Industrial Safety Office.

3.19 EXPLOSIVES

A. Explosives shall not be permitted on Government Property. This prohibition does not include the explosive cartridges/devices required to operate powder actuated tools.

3.20 SIGNS

A. Construction Identification Sign: Within 30 days after Notice to Proceed, the Contractor shall install the Government-furnished construction identification sign at the location designated by the Contracting Officer. This sign shall be securely installed in an acceptable manner approved by the Contracting Officer and shall be maintained in good condition and returned to the Government at project completion.

B. Other Signs and Advertisements: Only signs necessary to expedite deliveries, maintain traffic flow, promote safety (e.g. caution, danger, blasting, hardhat area), and prevent interference with Government operations shall be erected.

3.21 JOBSITE TRAILER (FOR GOVERNMENT)

A. Contractor shall provide an approximately 500 square foot trailer at the jobsite for use solely by the Government and government representatives. Contractor shall provide the original and four copies of the keys to the trailer; no one else shall have a key to this trailer. Trailer shall be heated and cooled and custodial services shall be provided at least once per week. Trailer is to be located adjacent to the superintendent's trailer. A refrigerator with at least 14 cubic feet and -potable water shall be provided for sole use by the Government. Trailer shall be divided into four (4) rooms: an office at each end, a restroom equipped with sanitary sewer services including running water, and a common area in the middle for drawings, files, and small meetings. Submit layout drawing for COTR's review and approval.

Attachment to Chapter 20, EP 1110-1-18, Ordnance and Explosives Response
UXO Personnel Training and Experience Hierarchy

Position Description	Training Required (Notes 1, 2, & 3)	Minimum Years of EOD/UXO Experience (Note 4)	Special Requirements
UXO Safety Officer	1, 2, or 3	10 years	Experience in all phases of UXO remediation and applicable safety standards
UXO Quality Control Specialist	1, 2, or 3	10 years	Experience in all phases of UXO remediation and the transportation, handling, and storage of ordnance and explosives materials
Senior UXO Supervisor	1, 2, or 3	15 years	Significant experience in all aspects of UXO remediation. Five years' experience in supervisory positions
UXO Technician III	1, 2, or 3	10 years	Prior military EOD and/or commercial UXO experience
UXO Technician II	1, 2 --- Or 3	N/A --- 5 years	Prior military EOD experience --- Experience in UXO remediation/range clearance operations. Plus specific project/ordnance training
UXO Technician I	1, 2, or 3	0	Successfully completed DOD certified course of instruction appropriate to this skill level
UXO Sweep Personnel	Equipment and site specific training	N/A	Equipment and site specific training. (Experience at this position is not required for UXO Technician I certification.)

Notes:

1. Graduate of the Army Bomb Disposal School at Aberdeen, MD.
2. Graduate of the Naval EOD School.
3. Graduate of a Department of Defense certified UXO Training Program.
4. This is the minimum experience requirement for designation. This is not an automatic designation, but reserved for those who have demonstrated the requisite knowledge, maturity, judgment, and are recommended by the contractor for recognition at the specified skill level.

END OF SECTION

SECTION 01 06 10 — GENERAL SAFETY AND ENVIRONMENTAL HEALTH REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

A. The publications listed below form a part of this contract as required by law or as referenced:

B. Code Of Federal Regulations (CFR)

1. Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation
2. 29 CFR Part 1910 Occupational Safety and Health Standards
3. 29 CFR Part 1926 Safety and Health Regulations for Construction
4. 40 CFR Parts 1- 1068 Protection of Environment

C. NASA/MSFC Publications

1. NPR 3792.1 Plan for a Drug-Free Workplace
2. NPR 8715.1 NASA Occupational Safety and Health Programs
3. NPR 8715.3 NASA General Safety Program Requirements
4. NPR 8820.2 Facility Project Requirements
5. NASA-STD-8719.11 Safety Standard for Fire Protection
6. MPR 1800.3 MSFC Sanitation Program
7. MPR 1840.4 MSFC Asbestos Program
8. MPR 1860.1 MSFC Radiation Safety Procedural Requirements
9. MPR 1860.2 Nonionizing Radiation Safety
10. MPD 1860.2 Radiation Safety Program
11. MPD 8500.1 MSFC Environmental Management Policy
12. MPR 8500.1 MSFC Environmental Engineering and Occupational Health Program
13. MPR 8500.2 MSFC Environmental Management System (EMS)
14. MWI 1810.1 Automated External Defibrillator (AED) Program
15. MWI 3410.1 Personnel Certification Program
16. MWI 8540.2 Green Purchasing Program
17. MWI 8550.1 Waste Management
18. MWI 8550.2 Storm Water Management
19. MWI 8550.3 Wastewater Compliance
20. MWI 8550.4 Air Emissions Compliance
21. MWI 8550.5 Hazardous Material Management
22. MWI 8621.1 Mishap and Close Call Reporting and Investigation Program
23. MPR 8715.1 Marshall Safety, Health, and Environmental (SHE) Program
24. MWI 8715.1 Electrical Safety Program

25. MWI 8715.2 Control of Hazardous Energy (Lockout/Tagout) Program
26. MWI 8715.10 Explosives, Propellant, and Pyrotechnics Program
27. MWI 8715.11 Fire Safety Program
28. MWI 8715.12 Safety, Health & Environmental Finding Tracking System (SHEtrak)
29. MWI 8715.13 Safety Concerns Reporting System (SCRS)
30. MWI 8715.15 Ground Operations Safety Assessment Program
31. MWI 8715.17 Hazardous Operations Readiness Review Program

D. Fire Protection

1. National Fire Protection Association (NFPA) codes
2. NFPA 241 "Standard for Safeguarding Construction, Alteration, and Demolition Operations"
3. NASA FAR Supplement 1852.223-73 Safety and Health Plan

E. NOTE: These documents can be accessed through the Marshall Integrated Document Library (MIDL) located on MSFC "Inside Marshall" Webpage or by contacting the Facilities Management Office (FMO) Contracting Officer Representative (COR).

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 "Submittals," in sufficient detail to shown full compliance with the contract documents.

B. Safety, Health and Environmental (SHE) Plan. The Contractor shall submit a Contractor SHE Plan that establishes the contractor's approach for implementing an industrial safety, occupational health, and environmental program that provides a workplace that is incident and injury free by (1) preventing employee fatalities, (2) reducing the number and severity of employee injuries and illnesses, and (3) protecting the environment through the ongoing planning, implementation, and management control of these programs in accordance with MPR 8715.1.

C. The Contractor's SHE Plan shall be written specifically for the work to be performed at MSFC and provide a clear description of the Contractor's approach for implementing their SHE Program at MSFC over the duration of this contracted effort.

D. The Contractor shall submit their SHE Plan to the FMO as directed in this TRSC section for review and approval prior to the contractor being notified to start work in accordance with NPR 8820.2, MPR 8715.1 and NASA FAR Supplement 1852.223-73.

E. The Contractor's SHE Plan shall address in sufficient detail their methods for implementing each of the following five (5) MSFC SHE Core Program Requirements (CPR) described in MRP 8715.1 while performing work at MSFC under this contracted effort.

F. NOTE: At MSFC, the topics listed below each CPR are considered as minimum fundamentals necessary to fulfill the CPR.

1. CPR 1 - Management Leadership and Employee Involvement

a. Policy to provide a safe and healthful work environment free from recognized hazardous conditions.
b. Accountability and responsibility for employees to perform work in a safe and healthful manner without endangering other employees or damaging property.
c. Authorization and necessary resources to reduce hazardous conditions in the work area to a safe working level.
d. Safety meetings and awareness training provided regularly to employees.

2. CPR 2- Worksite Analysis

a. Safety/risk assessments or hazard analysis of worksites, jobs and operations are performed to identify hazardous conditions and reduce these hazardous conditions to a safe working level.
b. Worksites, jobs and operations considered as hazardous are identified and communicated to employee.
c. Worksite inspections are performed regularly to identify hazardous conditions.
d. Employees are allowed to report safety-related concerns to management without fear of reprisal.
e. Safety, health and environmental services are provided at the worksite as needed.
f. Mishaps and close calls are reported and investigated to the extent necessary to determine the cause.
g. Drug tests are initiated for employees involved in mishaps and close calls as needed.

3. CPR 3 - Hazard Prevention and Control

a. Control methods adequate to reduce hazardous conditions to a safe working level are provided and implemented.
b. Hazardous operating procedures/instructions are provided for jobs/operations considered hazardous, as needed.
c. Emergency medical services are provided as needed.
d. Disciplinary program is implemented.
e. Emergency preparedness program is provided at the worksite as needed.

4. CPR 4 - Safety, Health and Environmental Training

a. Hazard awareness training is provided to employees.
b. Jobs/operations are evaluated to identify specific training needed for employees.
c. Training is provided to employees, so they are qualified and competent to perform their jobs/operations in a safe and healthful manner.

5. CPR 5 - Environmental Management System

a. Work activities are performed in compliance with all applicable environmental-related Federal, State, local regulations, NASA and Center requirements and environmental-related Executive Orders.

6. Contractor format is acceptable, but it is recommended that the Contractor's SHE Plan follow the order of the MSFC SHE CPR elements shown in MPR 8715.1 or provide a matrix that clearly identifies where each MSFC SHE CPR is addressed in the Contractor's SHE Plan.

7. The COR can require the Contractor to review and sign the MSFC Alternate SHE Plan for Construction prior to being allowed to start work at MSFC. When required the Contractor shall abide by all requirements identified in the MSFC Alternate SHE Plan for Construction. See "Attachment" at the end of this section for an example of the MSFC Alternate SHE Plan for Construction.

G. Reports. In addition to documentation and reports required elsewhere in this section, the following reports shall also be submitted:

1. Safety Statics Report: The Contractor shall complete MSFC Form 4371, MSFC Contractor Accident and Safety Statistics, and submit to the COR at the end of the project with the final payroll or at the frequency specified by the COR. If the contract is for a long duration, the COR in coordination with the ISB can determine the frequency that the Form 4371 is submitted. The Contractor shall ensure the form is complete and accurate in every detail and identify any information required by the form that is not applicable to the Contractor and/or scope of work.

1.4 GENERAL SAFETY PROVISIONS

A. Contractor shall:

1. Be subject to applicable Federal, State, local laws, NASA and Center regulations, ordinances, codes, and orders relating to safety, health and environmental in effect on the date of this Contract.

2. Be responsible for the control and safety of persons working on and visiting the project site during the performance of work under this contracted effort.

3. Be responsible for ensuring their employees and all subcontractor employees supporting them comply with all applicable federal, state, and local laws, regulations, ordinances, codes, and orders relating to safety, health and environmental and MSFC SHE requirements while working at MSFC.

4. Advise the FMO COR or FMO Project Manager (PM) of any special safety restriction he has established so that Government personnel can be notified of these restrictions.

5. Identify a "competent person" when required by 29 CFR 1910 or 29 CFR 1926. Post the name of this person(s) at the project site or designated meeting area where the workers gather prior to commencing work, and they shall be on the project site during any operation for which they have been identified as the "competent person." (NOTE: Use the "MSFC Emergency Telephone List" provided by FMO or ISB, or a similar format to post these names at the project site or designated meeting area.)

6. Use locks with a red case and tags with red diagonal strips containing the word "lockout" when controlling hazardous energy during construction, maintenance and servicing

activities in accordance with MWI 8715.2. Contractor employees that are expected to place a lock and/or tag or perform activities where the control of hazardous energy is needed are required to attend and complete the MSFC Lockout/Tagout Training. Contact the FMO or the MSFC Industrial Safety Branch (ISB) for more information on obtaining this training. Contractors are responsible for maintaining records of the completion of this training. (NOTE: Work on energized equipment shall only be allowed under special situation in accordance with MWI 8715.1.)

7. Conduct safety meetings/awareness training/toolbox meetings weekly at a minimum and retain documentation of these meetings at the construction site. Safety meeting sign-in sheets and a general description of the items covered shall be submitted to the COR or FMO PM.

8. Develop or use a job hazard analyses (JHA's), safety or risk assessment or Hazard Identification Safety Checklists (HIC) for jobs/operations identified as hazardous. These documents shall be retained at the construction site. (Hazard Identification Safety Checklists are located on the SHE web page under the "News and Information" pull down menu.

9. Provide MSFC SHE 101C, "MSFC SHE Program Construction Awareness Training" to employees. A copy of this training will be provided to the contractor by the ISB during the Pre-construction Conference. The contractor shall provide this training to all Contractor employees within 30 days of the Authority to Proceed (ATP) or their arrival at the worksite unless a different time limit is specified in the contract. It is recommended that this training be provided during a weekly safety meeting. Document the completion of this training by including the title of the training course, the names of the employees with their signatures and the date the training was provided. Notify the COR or FMO PM that this training has been completed. Maintain documentation of this training completion and provide to the Government upon their request.

10. Maintain in an orderly fashion, make readily available and provide all safety, health, and environmental related documentation (e.g., plans, forms, reports, supervisor safety visits, inspections, correspondence, JHA's, risk assessments, checklists, SDS, logs, and evidence of employee training/certifications) to the Government, upon request.

11. Ensure employee(s) are properly trained to perform their jobs/operations and when required to wear Personal Protective Equipment (PPE) has been trained in proper PPE usage in accordance with 29 CFR 1910.132(f) and MWI 8715.15. Documentation of this training shall be provided to the Government upon request.

12. NOTE: If training certificates are unavailable the Contractor may elect to provide a written document that provides rationale and clearly states why the Contractor considers the employee(s) as fully trained, knowledgeable, experienced, and qualified to perform the job/operation. The written document will only be accepted in lieu of a training certificate when it is written on a document that contains the company letterhead and is signed and dated by a company official or superintend. In either case the Contractor is assuming the responsibility that the employee is trained, knowledgeable, experienced, and qualified to perform the job/operation in a safe and healthful manner.

13. Provide a worksite that is easily identified, clearly separated from other ongoing activities in the same general area and effectively barricaded to prevent accidental entry into the worksite by unauthorized employees.

14. Provide protection against damage for structures, utilities, sidewalks, pavements, and other facilities that are immediately adjacent to excavations.

B. Hazard Communication (29 CFR 1910.1200). During the Pre-Construction Conference, to be arranged by the FMO, ISB and/or the Environmental Engineering and Occupational Health (EEOH) may discuss common safety and health requirements at MSFC and distribute handouts addressing these requirements.

1.5 ACCIDENT TREATMENT AND RECORDS

A. Contractor shall post emergency first aid, ambulance information, and a list of key personnel to be contacted in times of emergency at the project site. (NOTE: Use the "MSFC Emergency Telephone List" provided by FMO or ISB, or a similar format to post these names at the project site or designated meeting area.)

B. Contractor employees may utilize government dispensary facilities located in building 4249 for injury and emergency medical treatment. Contact occupational medicine services (telephone 256-544-2390).

C. Contractor shall report all accidents and incidents that occur at their work site that can result in injury or illness serious to Contractor employee or employees to the FMO Project Manager, FMO Construction Inspector and MSFC ISB.

1. Notify by the quickest means possible the Medical Ambulance Service and Medical Team (Telephone 911 and instruct the operator you are located at Marshall Space Flight Center and provide the building number and name of road or phone 256-544-4357 and select the appropriate option. For non-emergency call 256-544-2390.

2. Notify ISB at 256-544-0046.

a. Initial reporting for Type A, Type B, High-Visibility Mishaps and Close Calls – The initial reporting for these types of mishaps/close call shall be made as soon as possible after initiating emergency response, but no later than one hour of occurrence or awareness.

b. Initial reporting for Type C, Type D, Low-Visibility Mishaps and Close Calls– The initial reporting for these types of mishaps/close calls shall be reported as soon as possible after initiating emergency response, but no later than four hours of occurrence or awareness.

3. Notify the FMO COR, Project Manager or Government Construction Inspector.

D. The Contractor shall provide preform investigations and provide follow-up actions for reported accidents and incidents in accordance with MWI 8621.1, "Mishap and Close call Reporting and Investigation Program."

1.6 FIRE PREVENTION AND PROTECTION

A. Contractor shall comply with all fire prevention measures described in MWI 8715.11, "Fire Safety Program."

B. The Contractor shall obtain permission from the MSFC Authority Having Jurisdiction (AHJ) for fire protection, ISB or Fire Chief for the use of open flame devices, such as blowtorches, portable furnaces, tar kettles, or gas and electric welding and cutting equipment, in, on or within 25 feet of buildings.

C. Open-flame heating devices are not permitted except by approval of a hot work permit by ISB in accordance with MWI 8715.11, Fire Safety Program. Approval for the use of open-flame heating devices or open-fires does not relieve the Contractor from the responsibility for any damage incurred as a result of a fire.

D. Hot Work Permits are issued by ISB in accordance with MWI 8715.11, Fire Safety Program. Details for requesting a hot work permit will be provided by the ISB representative during the Pre-Construction Conference.

E. Burning trash, brush, or wood on the project site shall not be permitted.

F. Employees shall not be permitted to smoke inside any building located at MSFC (temporary, permanent or under construction).

G. Contractor shall be liable for any fire loss to Government property attributable to negligence on the part of the Contractor, including failure to comply with fire prevention measures prescribed in NASA STD 8719.11 and MWI 8715.11.

1.7 ELECTRICAL

A. Contractor shall appoint an employee to serve as the "competent employee" for electrical safety. This employee shall have received training in the hazards of electricity and familiar with the safety requirements in 29 CFR 1926. 400 – 449 (Subpart K) to be responsible for the electrical safety of the contracted effort and to restrict entry to dangerous locations to only those authorized by him and the FMO.

1.8 CONFINED SPACE ENTRY

A. The contractor shall obtain a permit prior to entering and accomplishing work in a designated confined space. At least 10 days prior to commencing activities, the contractor or sub-contractor shall submit to EEOH and ISB the following for review:

1. Training records showing personnel that have been trained in confined space entry in accordance with OSHA standard 29 CFR 1910.146.

2. Communication on company letterhead and signed by an officer or supervisor of the company stating that all personnel who are to work in the confined space entry have had appropriate training, physicals and are fit to safely perform the role they are assigned. The letter shall call out who are to act as entrants, attendants and entry

supervisors. At no time shall the person performing the job of Entry Supervisor also be an entrant unless another designated Entry Supervisor is present and duties are transferred.

3. A copy of the company's written confined space entry program.

4. Submission of this information earlier than 10 days is encouraged since failing to comply with this section can lead to delays and completion penalties.

B. Contractor shall be responsible for removing water and debris before commencement and during execution of work in manholes.

C. Contractor shall furnish their own atmospheric testing equipment and have one or more employees properly trained in operation of the testing equipment and formally qualified as Confined Space Entry Supervisors who shall be on duty during times workers are in confined spaces in accordance with 29 CFR 1910.146(g) &(j). Their primary functions shall be to perform the duties of Confined Space Entry Supervisor and to test for atmospheric hazards and operate testing equipment. Unless equipment of constant supervisory type with automatic alarm is employed, atmospheric tests shall be made at least every 30 minutes or more often when character of ground or experience indicates gas may be encountered. An atmospheric test shall be made before workers are permitted to enter the space after an idle period exceeding one-half hour, or more frequently at the discretion of the Contractor's Entry Supervisor or by direction of EEOH or ISB. A duly designated Confined Space Entry Supervisor may borrow atmospheric testing equipment from NASA's EEOH office, if the equipment is available.

D. Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical character, may be oxygen deficient. Consultation with and approval by EEOH and ISB is required prior to entering these types of confined spaces.

E. All manholes associated with water, sewer, steam, electrical, communication or any other utility are considered permit-required confined spaces and must be treated as such for entry.

1.9 RADIATION SAFETY REQUIREMENTS

A. The Contractor shall comply with 29 CFR1926.53, MPR 1860.1 and MPD 1860.2 for use of all radioactive material. The Contractor shall notify the MSFC Radiation Safety Officer (RSO) at least 48 hours in advance of any planned radiography. However, if planned during a weekend, notice shall be provided by Thursday. The Contractor shall report to the RSO once on-site and prior to starting work.

B. Loss of radioactive material shall be reported immediately to the COR and RSO.

C. Actual exposure of the radiographic film or unshielding the source shall not be initiated until after 5 p.m. on weekdays, unless prior approval is obtained from the COR and RSO to accomplish such activities prior to 5:00 p.m.

D. In instances where radiography is scheduled near or adjacent to buildings or areas having limited access or one-way doors, no assumptions shall be made as to building occupancy. Where necessary the COR will direct the Contractor to conduct an actual building entry, search,

and alert. Where removal of personnel from such a building cannot be accomplished and it is otherwise safe to proceed with the radiography, a fully instructed employee shall be positioned inside such building or area to prevent exiting while external radiographic operations are in process.

E. Contractor shall perform a hazard analysis (HA) when lasers are used or are in the work area. The HA shall be reviewed and approved by the RSO and ISB, and communicated to all personnel and all necessary protective measures taken.

1.10 ROOFING AND COATING

A. At the beginning of each work day the Contractor shall check with the Government Inspector before proceeding to work on the roof to ensure safe work conditions. Roofing and coating work shall adhere to NFPA-241.

B. Barricades or covers shall be provided for all roof openings which present a hazard.

C. Any employees designated to serve as a “Fire Watch” during roofing and coating operations where a tar kettle or similar fired equipment is used shall be trained in the use of fire-extinguishing equipment, familiar with the procedures for sounding an alarm in the event of a fire, and monitor the area where the hot work operation was conducted for at least 30 minutes after completion of the hot work operation to detect and extinguish any smoldering fires. Documentation of this training shall be provided to the Government, upon request.

1.11 TEMPORARY HANDRAILS AND GUARDRAILS (29 CFR 1910.23 and 29 CFR 1926 Subpart M – Fall Protection).

A. Temporary hand rails shall be provided on all stairwells until permanent hand rails are installed. All floor and wall openings from which there is a drop of more than 4' or there is a potential for employees to fall to a lower level shall be guarded by rail. Where there is exposure below of falling materials, a removable toe board or equivalent shall also be provided. In places where people are required to access an area close to or underneath walkways, handrails, and toe boards; approved netting shall be used.

B. Personal Fall Arrest Systems (PFAS) shall be provided to employees when they work on elevated surfaces where another fall protection system does not provide adequate fall protection. Employees shall be trained in the proper use and care of PFAS. Documentation of this training shall be provided to the Government, upon request.

1.12 TOOLS, HAND AND POWER (29 CFR 1910.241-244 (Subpart P), 29 CFR1926.300-307 (Subpart I).

A. Hand and power tools shall be in a safe operating condition and operators shall be familiar with their safe operations.

B. All portable electrically-powered tools used on this work shall be grounded by means of a 3-wire polarity type grounding system via ground fault interrupter unless the tool is UL-listed as

double-insulated. Operators of Power-operated tools shall be familiar with their safe operation in accordance with 29 CFR 1910.241 -244 (Subpart P) and 29 CFR 1926.300 – 307 (Subpart I).

C. Operators of explosive activated tools shall be trained to operate such tools in accordance with 29 CFR 1926.302(e) and provide documentation of this training to the Government, upon request.

1.13 WELDING, FLAME CUTTING, AND MELTING (MWI 8715.11, NFPA 241, 29 CFR 1926.350-354 (Subpart J)).

A. Contractor shall inform ISB of any welding and cutting operations and obtain a hot work permit before beginning the operations in accordance with MWI 8715.11.

B. Contractor shall ensure welding and cutting operators are familiar with the safe operation of welding and cutting equipment requirements in 29 CFR 1926.350 -354 (Subpart J).

C. Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour, or as required by the Hot Work Permit (MSFC Form 1155), after discontinuing these operations to make a thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound (6.8 kilogram) carbon dioxide fire extinguishers. Details for reporting fires will be provided by the ISB representative during the Pre-Construction Conference.

D. During operations involving possible fire hazard, the Contractor shall notify the COR and/or Government Inspector and not proceed until clearance is obtained in writing. COR and/or Government Inspector may request a standby from the Fire Station. This requirement does not relieve the Contractor of his responsibility for welding and cutting safety.

E. Roofing/Tar Melting/Handling Devices shall comply with the requirements of NFPA 241. Tar melting kettles and handling devices shall be used in a safe manner to eliminate any chance of an employee being burned or starting a fire. Melting kettles shall be placed on a level, firm foundation and protected against traffic, accidental tipping or similar hazard. An approved type of fire extinguishers shall be available at all locations where melting kettles or heating devices are in use. Melting kettles or heating devices, when in use, shall be provided with a lid and thermometer.

F. Any employees designated to serve as a “Fire Watch” during welding, flame cutting and melting shall be trained in the use of fire-extinguishing equipment, familiar with the procedures for sounding an alarm in the event of a fire, and monitor the area where the hot work operation was conducted for at least 30 minutes after completion of the hot work operation to detect and extinguish any smoldering fires. Documentation of this training shall be provided to the Government upon request.

1.14 HIGH NOISE LEVEL PROTECTION (29 CFR 1910.132(f))

A. Contractor shall ensure employees wear appropriate hearing protection when performing operations that involve the use of equipment with output of high noise levels (jackhammers, air compressors, etc.) shall be scheduled for weekends or after duty working hours as directed at

the pre-construction conference. Use of any such equipment shall be approved in writing by the COR prior to commencement of work.

B. When the sound pressure level in any working area exceeds 85 dBA, personnel shall be required to wear hearing protective devices in accordance with 29 CFR 1926.101.

C. When the sound pressure level in any work area exceeds 120 dBA, hearing protection equivalent to the combination of ear plugs and ear muffs shall be required.

1.15 SEVERE STORM EVACUATION PLAN

A. In the event of a severe storm warning, the Contractor shall:

1. Secure outside equipment and materials and place materials possible to damage in protected locations.
2. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.
3. Ensure that temporary erosion controls are adequate.
4. Vacate temporary construction trailers
5. Go to the nearest protective area identified by the FMO PM.

1.16 SCAFFOLDS AND LADDERS (29 CFR 1926 Subpart L, 29 CFR 1926.454, 29 CFR 1910.66, 29 CFR 1910.28-29 and 29 CFR 1910.24-27)

A. The Contractor shall comply with the requirements of 29 CFR 1926 Subpart L and 29 CFR 1910.66 for use of scaffolds. All scaffolds, ladders, platforms, and runways shall be erected, inspected and maintained in accordance with the applicable sections listed above.

B. An adequate number of ladders shall be furnished at all times. Job constructed ladders shall be of select materials. All fixed ladders above 20 feet in height shall be staggered or caged. All ladders placed on concrete floors or slippery surfaces shall be equipped with an approved type no-skid shoe or otherwise adequately made to prevent slipping.

1.17 ROPES/SLINGS/CHAINS

A. No loads shall pass over workmen and other personnel at any time. Slings, their fittings and fastenings, when in use, shall be inspected daily by a qualified craft person for evidence of overloading, excessive wear or damage. Defective slings shall be removed from service. Proper storage shall be provided for qualified slings when not in use. Wire rope shall be inspected by a competent person at the time of installation and at scheduled intervals thereafter. Drums, sheaves, or pulleys having eccentric bores or cracked hubs, spokes, or flanges shall be removed from service. To eliminate rope damage: drums, sheaves, and pulleys shall be smooth and free of surface defects.

B. Connections, fittings, fasteners, parts, etc., used in connection with ropes shall be of good quality and of proper size and strength, and shall be installed in accordance with recommendations of the manufacturer. Chains used for lifting loads shall be inspected before each use. After the initial inspection, the chains shall be inspected each week. Chains shall be

removed from service when showing evidence of cracks, nicks, or other damage. All hooks, used to support human loads (on approved lifting devices) or any loads, shall be closed or equipped with a safety latch.

C. Hooks, shackles, rings, pad eyes, and other fittings that show excessive wear or that have been bent, twisted or otherwise damaged shall be removed from service. Frozen fiber rope shall not be used. Fiber rope that has been subjected to acids or excessive heat shall not be used. Fiber rope shall be protected from abrasion by padding where it is fastened. The same protection applies for fiber rope drawn over square corners, sharp or rough surfaces.

D. The Contractor shall ensure employees performing rigging and hoisting operations are trained and familiar with the safety requirements in 1926.753 and 761. Documentation of this training shall be provided to the Government upon request.

1.18 OPERATIONS ADJACENT TO POWER LINES

A. Equipment or any part thereof shall not have the capability of coming within the following minimum clearances from energized power lines. Positioning and blocking of equipment to assure that no part thereof, including cables, can come within the following minimum clearances will be considered an acceptable alternate.

Power Lines Nominal System KV	Minimum Required Clearance (Feet)
5	3
15	8
44	10
69	12
115-161	15

B. A notice of the minimum required clearance shall be posted at the operator's position.

C. The Contractor shall ensure employees performing operations adjacent to power lines are trained and familiar with the safety requirements in 29 CFR 1926. 950 – 960 (Subpart V). Documentation of this training shall be provided to the Government upon request.

1.19 CONSTRUCTION EQUIPMENT

A. All construction equipment and machinery, including required guards, brakes, cable, etc., shall be inspected by qualified personnel before use for safe and serviceable mechanical condition. All inspections shall be done daily before each shift and will be properly maintained by qualified personnel. A warning device or service of a Signal-man shall be provided where there is danger to personnel from moving equipment, swinging loads, buckets, booms, etc. All equipment capable of hauling 5 tons of material is considered to be heavy duty and shall be equipped with an emergency brake system. The State Commercial Drivers License, (CDL) requirement and regulation applies on Redstone Arsenal. Documentation of this training shall be provided to the Government upon request.

B. Before any machinery or mechanized equipment is placed in use, it shall be inspected and tested by a competent mechanic and certified to be in safe operating condition. Records of tests and inspections will be maintained at the site and will be available to the Government upon request. All machinery or equipment found to be unsafe shall be tagged out and its use prohibited until unsafe conditions have been corrected. Machinery or equipment requiring an operator shall not be permitted to run unattended. Equipment shall be locked or secured to prevent operation by unauthorized personnel. All guards and devices shall be replaced immediately after completion of repairs and adjustments.

C. The Contractor shall ensure employees working with construction equipment are trained in its safe operation and are familiar with the safety requirements in 29 CFR 1926. 600 – 606 (Subpart O). Documentation of this training shall be provided to the Government upon request.

D. Self-propelled construction equipment (except light service vehicles), crawler-type equipment, such as cranes, power shovels and draglines, whether moving alone or in combination shall be equipped with a reverse signal alarm in accordance with 29 CFR 1926.601.

1. The alarm shall be mounted on the rear of the equipment and shall withstand severe wear and tear, adverse weather, and unfavorable environmental working conditions and shall be certified by the manufacturer as fully meeting the following performance standards.
2. The alarm shall produce a relatively pure tone which shall peak within the United Standard Association standard octave passband of 600 to 2,400 cycles per second and shall produce a 0.2 to 0.5 second audible warning within the initial 3 feet of backward movement of the vehicle on which it is mounted and at regular intervals, not to exceed 3 seconds, throughout the backward movement. The alarm shall automatically cut out when the backward movement ceases. The sound intensity of the alarm shall range from and not exceed 100 dB at a horizontal distance of 5 feet from the alarm.
3. Actuation of the alarm shall be automatic by direct connection to any part of the equipment that moves or acts in a manner distinctive only to the rearward movement of the vehicle with no manual controls of any kind between the source of actuation and the alarm. Where application of this requirement to specific types of equipment has impractical application, other means of actuation may be used upon written approval of the CO.

1.20 TEMPORARY ELECTRICITY AND LIGHTING

A. All temporary wiring shall be in accordance with the National Electric Codes, OSHA standards, and installed by competent personnel. Adequate, safe lighting shall be provided in advance for any work requiring artificial light. Grounding of all electrical portable equipment and hand tools shall be accomplished by installing three-wire plug systems. All 120 volt, single-phase, 15 and 20 ampere receptacle outlets on construction sites which are not part of the permanent wiring of the building or structure and which are in use by employees shall have approved ground fault circuit interrupters (GFCI) for personnel protection.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

ATTACHMENT

September 12, 2013

Alternate Safety, Health and Environmental (SHE) Plan for Construction

Company Name:	
Contract Number:	**Date:**
MSFC Organization supported:	
MSFC Contracting Officer:	
MSFC Contracting Officer Representative:	
Contract begin date:	**Contract End date:**

Marshall Space Flight Center (MSFC) is committed to providing a workplace that is incident and injury free by (1) preventing employee fatalities, (2) reducing the number and severity of employee injuries and illnesses, and (3) protecting the MSFC environment and property by implementing the five (5) MSFC SHE Program Core Program Requirements (CPRs). During (or for the duration of) the construction, alteration, demolition and/or repair of this contracted effort shall:

_____

(company name)

CPR 1 – Management Leadership and Employee Involvement

1. Provide a visible management commitment, policy, and culture that value the safety and health of employees and provides a safe and healthful workplace free from incidents and injuries.

2. Protect MSFC property and the environment over the duration of this contracted effort.

3. Perform work activities and operations in compliance with EPA, OSHA, NASA, MPR 8715.1 and all MSFC SHE documents listed in 1.02B that contain requirements applicable to this contracted effort.

4. Hold supervisors and employees accountable to perform their work activities in a safe and healthful manner and also understand their roles and responsibilities in the SHE Program.

5. Authorize and provide the necessary resources for the elimination, reduction or for controlling identified hazardous conditions to a safe working level.

6. Evaluate the safety performance of subcontractors or teammates prior to their selection to perform any work in support of this contracted effort, where applicable.

7. Flow down responsibilities and requirements contained in this contracted effort to subcontractors and teammates over the duration of this contracted effort, when applicable.

8. Provide SHE meetings/toolbox meeting/safety awareness training to employees at least weekly and document. (**NOTE**: Contractors shall maintain documentation of these meetings and provide to the Government, upon request).

9. Maintain the SHE Plan current with contract, NASA and MSFC requirements, review and update as necessary. Provide the frequency of this review.

10. Provide the identification, by title, of the individual assigned by the contractor to be responsible to implement the contractor's SHE program elements and designated to serve as the day-to-day SHE Point of Contact (POC) for

this contracted effort. [**NOTE:** The names of these employees shall be posted on the attached Emergency Phone listing.]

CPR 2 – Worksite Analysis

11. Evaluate work areas, jobs and operations by the use of job hazard analysis, safety or risk assessments, or hazard identification safety checklists to identify hazardous conditions and implement the appropriate control measures to eliminate, reduce or control hazardous conditions to an acceptable safe working level.

12. Reevaluate work areas, jobs and operations when significant changes are made to verify that existing control measures are still effective in controlling the hazardous conditions. (**NOTE 1**: This also includes evaluating health conditions to identify and prevent an occupational disease.) (**NOTE 2**: Contractors shall maintain documentation of these evaluations and provide to the Government, upon request).

13. Perform worksite safety inspections of the worksite at least weekly and document. (**NOTE**: Contractors shall maintain documentation of these inspections and provide to the Government, upon request).

14. Encourage employees to report any condition that they feel is hazardous or unsafe without the fear of reprisal from management.

15. Report all contractor mishaps and close calls that occur in support of this contracted effort and investigate to the extent necessary to determine the proximate or root cause(s), develop and implement corrective actions, and track to closure in accordance with MWI 8621.1. Contact the COR, FMO Project Manager or MSFC Industrial Safety Branch for assistance if needed.

16. Perform post-mishap drug and alcohol testing when the initial mishap investigation provides reason to believe an employee's actions or failure to perform a required action is reasonably suspected of having caused or contributed to causing the mishap in accordance with NPR 3792.1, "Plan for Drug-Free Workplace."

CPR 3 – Hazard Prevention and Control

17. Perform a supervisor level review for work activities identified as hazardous or safety critical prior to them being started.

18. Perform work at MSFC in full compliance with the MSFC SHE documented programs listed in 1.02B that contain requirements that are applicable to this contracted effort while working onsite at MSFC (e.g., Personal Protective Equipment (PPE), Respiratory Protection, Hazard Communication, Confined Space Entry, Lockout/Tagout, Bloodborne Pathogens).

19. Provide an emergency management program at the worksite for all types of emergencies that can occur during this contracted effort (e.g., fire, chemical spill, accidents, natural disasters). (**NOTE 1**: Contractors located at the Center, when applicable, should contact their Contracting Officer or Contracting Officer Representative for additional instructions.) (**NOTE 2**: A list of emergency phone numbers and points-of-contacts is recommended to be posted at the worksite for employee reference.)

20. Provide the necessary safety, health, and environmental services at the worksite (i.e., hazardous waste disposal, industrial hygiene monitoring, emergency medical support, hearing conservation program, respiratory protection, and hazard communication, etc.). Provide a list of environmental and health services that will not be provided by MSFC.

21. Provide a worksite that is easily identified, clearly separated from other ongoing activities in the same general area and effectively barricaded to prevent accidental entry into the worksite by unauthorized employees.

22. Provide protection against damage for structures, utilities, sidewalks, pavements, and other facilities that are immediately adjacent to excavations.

23. Provide fall protection to employees that will be walking/working surfaces with unprotected sides or edges where the potential exists for them to fall to the next lower level in accordance with 29 CFR 1926.501, 29 CFR 1926.502, 29 CFR 1910.23 and MPR 8715.1.

24. Develop a "site specific (building) fall protection plan" when a conventional fall protection system cannot be used to provide fall protection at the worksite and submit for approval to the COR and MSFC Industrial Safety Branch (ISB) in accordance with 29 CFR 1926.501(k) and MPR 8715.1.

25. Develop operating procedures/instructions for operations identified as hazardous or safety critical, or when directed by MSFC ISB, EEOH or FMO.
[**NOTE**: The operating procedures/instructions shall be documented, clearly identify the potentially hazardous situations, the mitigation techniques necessary to control the concern/hazard, and made available to the Government upon request.]

CPR 4 – Safety, Health and Environmental Training

[NOTE: The preferred method documenting an employee's training is to provide a certificate of training that contains (1) the name of the training, (2) date the training was provided, (3) name of the company that provided the training, and (4) the employee's name that indicates the employee attended the training and met all training requirements. In cases where a certificate of training is unavailable for an employee the Contractor can elect to provide an alternate documentation of employee training. The alternation documentation shall (1) be written on a document that contains the company letterhead, (2) rationale that clearly states why the employee is considered as trained, knowledgeable, experienced, and qualified to perform the job/operation, and (3) signed and dated by an a company official or supervisor. In either case the Contractor is assuming the responsibility that the employee is trained, knowledgeable, experienced, and qualified to perform the job/operation in a safe and healthful manner.

26. Provide training to employees so they are informed, knowledgeable and are able to recognize hazardous conditions in the workplace and the signs and symptoms of workplace-related illnesses, understand the safe work practices and procedures to be used in the workplace, and are empowered and authorized to "stop or halt" any activity when they have reason to suspect the activity is being performed in an unsafe or unhealthy manner in accordance with 29 CFR Part 1926.21(b)(2). [**NOTE**: This training can be accomplished during a safety (toolbox) meeting and evidence of this training made available to the Government upon request.]

27. Clearly communicate to all employees the contractor's disciplinary policy/program, so that each employee fully understands the actions that can be taken by the contractor when an employee is discovered not following safety, health, and environmental policies, procedures and rules, and the disciplinary actions are warranted.

28. Evaluate each job/operation performed by contractor employees to identify the specific training required by the applicable parts of 29 CFR 1910 and 29 CFR 1926, and provide the specific training to employees prior to them performing the job/operation.

a. Operate Contractor owned equipment and machinery in accordance with 29 CFR 1926.20(a)(4)
b. Handle or use poisons, caustics, and other harmful substances in accordance with 29 CFR 1926.21(b)(3).
c. Enter into confined or enclosed spaces in accordance with 29 CFR 1926.21(b)(6). [**NOTE**: At MSFC all manholes associated with water, sewer, steam, electrical, communication or any other utility are considered permit-required confined spaces and must be treated as such for entry. This includes provisions such as, but not limited to, written confined space program, documentation of appropriate training, atmospheric testing and retrieval equipment.]
d. Operate any MSFC owned lifting equipment (forklift, crane, etc.) in accordance with MWI 3410.1.
e. Perform rigging and hoisting operations in accordance with 29 CFR 1926.753-761 and 29 CFR 1910.178(l)6).
f. Perform operations adjacent to power lines in accordance with 29 CFR 1926.950-960.
g. Operate or use construction equipment considered as heavy equipment or machinery in accordance with 29 CFR 1926.600-606.
h. Wear personal fall arrest system in accordance with 29 CFR 1926.503.
i. Wear Personal Protective Equipment in accordance with 29 CFR 1910.132.
j. Designated as "qualified" to operate equipment and machinery, and perform the work activities that they have been assigned in accordance with the applicable parts of 29 CFR 1910 and 29 CFR 1926.
k. Designated as "competent person" for any operation identified in 29 CFR 1910 or 29 CFR 1926 that require a "competent person."
(**NOTE**: Contractors shall maintain documentation of this training and provide to the Government.)

29. Provide MSFC SHE Program Awareness Training to all employees within 30 days of the Authority to Proceed (ATP) or their arrival at the worksite. [**NOTE** 1: Contact Facilities Management Office (FMO) Project Manager or Industrial Safety Branch (ISB) to receive a copy of this training. **NOTE** 2: Contractors shall maintain a record of this training and made available to the Government, upon request.]

30. Provide MSFC Safety Certification to employees when required by the ISB or Environmental Engineering and Occupational Health (EEOH) Office. (**NOTE**: At the present time if the Contractor is expected to operate MSFC owned lifting equipment in accordance with MWI 3410.1 a MSFC Safety Certification is required.)

31. Inform all employees on the methods of how to report an emergency or accident while working at MSFC. [**NOTE**: Call 4-HELP (4357) and select the appropriate option. If using a cell phone call 911 and tell the operator you are located at Marshall Space Flight Center, provide building number and road name.]

CPR 5 – Environmental Management System

32. Comply with the MSFC Environmental Management System (EMS). The EMS provides the necessary training and procedures to ensure NASA's compliance with all environmental laws and regulations. Environmental procedures are as follows:

a. MPD 8500.1 "MSFC Environmental Management Policy"
b. MPR 8500.1 "MSFC Environmental Engineering & Occupational Health (EEOH) Program"
c. MPR 8500.2 "MSFC Environmental Management System"
d. MWI 8540.2 "Green Purchasing Program"
e. MWI 8550.1 "Waste Management"
f. MWI 8550.2 "Storm Water Management"
g. MWI 8550.3 "Wastewater Compliance"
h. MWI 8550.4 "Air Emissions Compliance"
i. MWI 8550.5 "Hazardous Material Management"

[**NOTE**: Coordination with EEOH is required.]

ADDITIONAL REQUIREMENTS

Pre-work Inspections

33. Erect and inspect scaffolds prior to use each day in accordance with 29 CFR Subpart L and 29 CFR Part 1910.66 and 29 CFR 1926.451(f)(3).

34. Dig, form and inspect excavations/trenches prior to entry and as needed throughout the day in accordance with 29 CFR 1926.651, 29 CFR 1926.652 and 29 CFR 1926.651(k).

[**NOTE**: Evidence of these inspections shall be documented and made available to the Government upon request.]

Equipment and Tools

35. Provide Contractor owned or rented hoisting equipment (cranes and forklifts) that have their rated load capacities conspicuously posted on the equipment in accordance with 29 CFR 1926.550(a)(2) if brought on MSFC.

36. Provide Contractor owned or rented motorized vehicles and lifting equipment that comply with the applicable requirements in 29 CFR 1910.178 – 184, 29 CFR 1926.606, 1000-1003, and 1501 if brought on MSFC. [**NOTE**: Documentation of equipment inspections shall be made available to the Government upon request.]

37. Provide a documented annual inspection for Contractor owned or rented hoisting equipment (cranes and forklifts) in accordance with 29 CFR 1926.550(a)(6) if brought on MSFC. [**NOTE**: Documentation of the annual inspection shall be made available to the Government upon request.]

38. Perform a visual inspection of each hoisting equipment (cranes or forklifts) prior to use in accordance with 29 CFR 1926.753(c)(1).

39. Remove any equipment, machinery or tools if it is discovered to be in an unsafe operating condition in accordance with 29 CFR 1926.20 (a)(3).
[**NOTE**: Equipment, machinery or tools discovered in an unsafe operating condition shall be removed from the worksite or identified (tagged) as unsafe, or rendered inoperable by the use of a lock.]

40. Provide a reverse signal alarm on all self-propelled construction equipment in accordance with 29 CFR 1926.601. [**NOTE**: This is not required for light service vehicles.]

41. Locate and store equipment and materials outdoors so to not cause possible damage to other buildings or structures during severe weather.

Electrical Equipment

42. Provide power portable tools that are double-insulated or grounded by means of a 3-wire polarity type grounding system via a ground fault interrupter in accordance with 29 CR 1926.302.

43. Provide ground-fault circuit interrupters (GFCI) on all single-phase 15 and 20 ampere receptacle outlets used by employees at the worksite during the construction in accordance with 29 CFR 1926.404(b)(1).

44. Provide cord sets and receptacles that are equipped with a grounding plug and are grounded in accordance with 29 CFR 1926.404(b)(1). [**NOTE**: This applies to cord sets and receptacles that are not part of the permanent building structure.]

45. Apply lockout devices to equipment and systems when required in accordance with 29 CFR 1910.147, 29 CFR 1926.417 and MWI 8715.2. [**NOTE** 1: At MSFC all locks used for locking out equipment/system while an employee is working on the equipment/system shall be identified by a “red” colored case. These lockout devices shall also be identified with tags containing “red diagonal stripe”. Reference MWI 8715.2 for more information.]
[**NOTE** 2: Work on energized equipment is strictly prohibited at MSFC, but occasionally a situation will arise where this is not possible. In these situations an Energized Electrical Work Permit shall be required. Contact FMO for more information.]

Lighting

46. Provide adequate lighting (permanent or temporary) in the work area that enables employees to safely perform their jobs/operations in accordance with 29 CFR 1926.26.

Fire Protection

47. Provide fire protection equipment that is appropriate for the work being performed at the worksite in accordance with 29 CFR 1926.24. [**NOTE** 1: Portable fire extinguishers are to be located at the worksite and accessible to employees.] [**NOTE** 2: Any employee that might use a portable fire extinguisher are to receive training in the general principles of fire extinguisher use and the hazards involved with incipient stage firefighting in accordance with 29 CFR 1910.157.]

Barricades

48. Erect barricade fencing that is effective in preventing unauthorized entry around the worksite and hazardous conditions such as excavations, trenches, etc. in accordance with 29 CFR 1926.200 -203, Subpart G.

[**NOTE**: Orange mesh barricade fencing is the preferred method for construction at MSFC, but other means (signs, signals, tags) of warning employees are also acceptable. The FMO inspector or ISB can provide more information.]

49. Provide protection against damage for structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations.

Personal Protective Equipment

50. Communicate Personal Protective Equipment (PPE) requirements to employee whose jobs/operations can expose them to hazardous conditions in accordance with 29 CFR 1926.28 and MWI 8715.15. [**NOTE**: The communication can be by the use of signs posted at the worksite that clearly identify the type PPE and when it is required to be worn.]

Personal Fall Arrest System (PFAS)

51. Provide a system that ensure PFAS and associated positioning device systems are inspected prior to each use in accordance with 29 CFR 1926.502(d)(21) and 29 CFR 1926.502(e)(9).

52. Provide a system that ensures PFAS are inspected at least on a semi-annual basis by a Competent or Qualified person in accordance with ANSI A10.32 (2004) section 6.3).
[**NOTE**: Documentation of equipment inspections shall be made available to the Government upon request.]

Housekeeping

53. Remove all scrap lumber and debris from work areas, passageways and stairs in accordance with 29 CFR 1926.25(a).

54. Remove combustible scrap and debris from the worksite at regular intervals in accordance with 29 CFR 1926.25(b).

55. Provide waste/trash containers at the worksite empty them at regular intervals in accordance with 29 CFR 1926.25(c). [**NOTE**: Containers for garbage and other oily, flammable, or hazardous wastes, such as caustics, acids, harmful dusts, etc. shall be equipped with covers and the covers kept closed.]

Permits/Plans

56. Obtain the following abatements/impairment plans when needed for:

Lead removal – 29 CFR 1926.62
Asbestos removal - 29 CFR 1926.1101
Fire Protection system outages – 29 CFR 1926.150 and MWI 8715.11

57. Obtain the following permits when needed:

Hot Work Permits (MSFC Form 1155) shall be required for activities that are not performed in a MSFC Designated Hot Work Area and use an “open flame”, welding, cutting, grinding, Tar Kettles. etc.
[**NOTE**: All hot work shall end 1 hour prior to the end of the normal work day.]

- Digging Permit (MSFC Form 4392) shall be required for all excavations and trenching
- Confined Space Entry Permit (MSFC Form 2519) shall be required for all entries in MSFC spaces identified as a confined space in accordance with MWI 1840.1.
- Energized Electrical Work Permit (MSFC Form 4462) shall be required if the equipment or system cannot be de-energized to perform work.
  [**NOTE**: No work shall be performed on energized equipment without concurrence from FMO and approval from ISB.]

- Air Emissions Permit (coordinate with EEOH 256-544-4246) shall be required if the equipment or process emits fumes, smoke, particles, dust, chemicals, or other emissions into the air. If the following equipment is installed on site, it shall be evaluated for air emissions permit requirements before installation:
  - Fuel burning equipment (examples: boilers, incinerators, generators, engines, etc)
  - Paint booths
  - Sand/Grit blasters
  - Surface coating equipment
  - Machine shops
  - Woodworking shops
  - Chemical baths, vapor degreasers, solvent cleaning equipment/operations
  - Air strippers/water purification
  - Tanks containing Volatile Organic Chemicals (VOC's) (examples: gasoline tanks, diesel tanks, etc.)
  - Liquid rocket engine, solid motor, or component testing
  - Vapor degreasing
  - Laboratory equipment
  - Equipment for melting or applying wax
  - Hydraulic or hydrostatic test equipment
  - Brazing, soldering, or welding
  - Non-digital photography
  - Exhaust/fume hoods
  - Parts Washers
- Storm Water Permit

General

58. Instruct all employees on the methods to receive emergency medical attention at MSFC in accordance with 29 CFR 1926.23 & 50. [**NOTE**: First aid is available to all employees at the MSFC Medical Center, building 4249 for job related illnesses and injuries.]

59. Identified employee(s) to serve in the role of a "Competent person" for pre-job inspections/verifications/activities (scaffolding, trenches, etc.) as required by the applicable subparts of 29 CFR 1910 and 29 CFR 1926 for this contracted effort. [**NOTE** 1: A "competent person" is identified in 29 CFR 1926.32 and 29 CFR 1910 as "capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who have authorization to take prompt corrective measures to eliminate them."] [**NOTE** 2: Justification/rational of selecting these employees shall be documented (employee's training, work experience and knowledge of the job/operation) and made available to the Government upon request. The name(s) of the "Competent person(s) and the corresponding job/operation for which that are designated to serve as the "Competent person" shall be listed on the attached Emergency Phone listing, Appendix C and posted at the project site or designated meeting area where the worker gather prior to commencing work.]

60. Appoint an employee to be "in charge and responsible" and is physically located onsite while work is being performed. [**NOTE**: This is normally a job superintendent or foreman.]

61. Provide a list of company employee(s) to be contacted in the event of an emergency while work is performed onsite under this contracted effort.

62. Post the "Emergency Phone List" Appendix C at the project site, or a designated meeting area where workers gather prior to commencing work, or for other activities. The "Emergency Phone List" can also be located in company vehicles if the Contractor does not have a designated meeting area.

63. Provide additional requirements not previously listed, if required, specific to the work performed under this contracted effort in Appendix A.

64. Instruct employees to adhere to the MSFC emergency procedures when there is a probability of exposure to Unexploded Ordnance (UXO), hazardous or radiological material.

65. If Unexploded Ordnances (UXO) are suspected of being in the worksite notify the FMO Construction Management Inspector to contact the UXO services organization to perform an assessment/investigation of the worksite in accordance with the MSFC Technical Specifications for Repair and Construction (TSRC) section 01 05 90.

REPORTS/DOCUMENTATION SUBMITTAL

Reports/documentation listed below shall be made available to the Government upon request.

1. Safety (toolbox) meeting and/or safety awareness training documentation
2. Safety Assessments: Hazard Analysis (HA) or Job Hazard Analysis (JHA), Hazardous Inventory Checklists (HIC) for the work being performed
3. Worksite inspections conducted by the contractor documentation
4. Employee training/qualification/certification records
5. Equipment inspections conducted by the contractor documentation
6. Safety Data Sheets (SDS) for chemical and hazardous materials
7. Storm water inspection reports
8. Green purchasing reports
9. Construction Best Management Practices Plan (CBMPP)
10. Waste Management plan

SUBMISSIONS FREQUENCY

1. Submit MSFC Contractor Accident and Safety Statistics (MSFC Form 4371) or an equivalent method to the Contracting Officer Representative (COR) or FMO representative designated by the COR. This information shall be provided to the COR in accordance to the reporting requirements and frequency determined by the COR. At a minimum the following information shall be provided:
   - Contract number
   - North American Industry Classification System (NAICS)
   - Number of employees and supervisors
   - Number of hours worked
   - Lost work day cases, days away from work, and restricted work days
   - Number of safety meeting and worksite inspection

2. Initial reporting for Type A, Type B, High-Visibility Mishaps and Close Calls – The initial reporting for these types of mishaps/close call **shall be made as soon as possible after initiating emergency response, but no later than one hour of occurrence or awareness.**

2.1 Initial reporting for Type C, Type D, Low-Visibility Mishaps and Close Calls– The initial reporting for these types of mishaps/close calls **shall be reported as soon as possible after initiating emergency response, but no later than four hours of occurrence or awareness.**

2.2 Initial report shall be made to the MSFC ISB by one of the following: 1) Call the Safety Hotline at (256)-544-0046 or 4-HELP (4-4357), select the appropriate option, or 2) Submit a "SHE Report" located on "Inside Marshall," or 3) Direct input to the NASA Incident Reporting Information System (IRIS) Quick Incident Report located at https://nasa.ex3host.com/irisquickincident/safety_default.asp., or an equivalent electronic notification method to notify the MSFC ISB, and 4) Notify the FMO Construction Inspector.

The link to the "SHE Report" is located at the bottom of the "Inside Marshall" web page under the "MSFC Safety Reporting System" link. Open "SHE Reporting," select "Continue to SHE Report Form," select "Category," select "Incident or Mishap" and enter all the required information,

2.3 The initial reporting for all mishaps/close calls shall include 1) location and time of incident, 2) number of fatalities and/or hospitalized employees (if known), 3) Company or MSFC organization contact person and phone number, 4) a brief description of the mishap/close call including damage to equipment and/or facilities.

3. Follow-up reporting and documentation of a mishap/close call shall be within 24 hours of initial notification to the FMO Incident Reporting Information System (IRIS) administrator or ISB in accordance with MWI 8621.1.

The extent of investigation to determine the root cause of the mishap or close shall be conducted in accordance with MWI 8621.1.

Approval Signatures

By signing this Alternate SHE Plan the Contactor confirms their agreement and commitment to (1) provide a workplace that is incident and injury free, and (2) to adhere to and comply with all of the requirements contained in MPR 8715.1, MWI 8621.1 and other MSFC SHE documents identified above as applicable to the jobs/operations associated with this contracted effort while working on MSFC.

Contract Number: _____

Company Name: _____

Company Onsite Superintendent/Foreman

(print):_____

(signature):_____Date:_____

Company Onsite SHE representative

(print):_____

(signature):_____Date:_____

APPENDIX A
Additional Information

List of jobs/operations identified as hazardous or safety critical.
List of hazardous operating procedures/instructions
List of JHA, Risk Assessments, or Hazard Identification Safety Checklists
List additional requirements that are specific to the work performed under this contracted effort, if necessary.

1.

2.

Appendix B
Applicable Documents

"Check the box" of the following MSFC SHE Program documents that are **NOT** applicable to the work being performed under this contracted effort.

No.		**Federal Directives and Standards**
1		29 CFR Part 1910, Department of Labor, Occupational Safety and Health Administration Standards for General Industry
2		29 CFR Part 1925, Safety and Health Standards for Federal Service Contracts
3		29 CFR Part 1926, Department of Labor, Occupational Safety and Health Administration Standards for Construction
4		CFR Title 40 Parts 1-1068, Protection of the Environment
5		ANSI Stds., American National Standards Institute, applicable to the scope of this contract (ANSI 10.32)
6		ASME, American Society of Mechanical Engineers, applicable to the scope of this contract
7		NFPA, National Fire Protection Association
8		CGA, Compressed Gas Association, applicable to the scope of this contract
		NASA Directives
9		NPR 3792.1, Plan for a Drug-Free Workplace
10		NPR 8715.1, NASA Occupational Safety and Health Programs
11		NPR 8715.3, NASA General Safety Program Requirements
		MSFC Directives
12		MPR 1840.4, MSFC Asbestos Program
13		MPR 1860.1, MSFC Radiation Safety Procedural Requirements
14		MPD 1860.2, Nonionizing Radiation Safety Program
15		MPD 8500.1, MSFC Environmental Management Policy
16		MPR 8500.1, MSFC Environmental Engineering and Occupational Health Program
17		MPR 8500.2, MSFC Environmental Management System (EMS)
18		MWI 1810.1, Automated External Defibrillator (AED) Program
19		MWI 3410.1, Personnel Certification Program
20		MWI 8540.2, Green Purchasing Program
21		MWI 8550.1, Waste Management
22		MWI 8550.2, Storm Water Management
23		MWI 8550.3, Wastewater Compliance
24		MWI 8550.4, Air Emissions Compliance
25		MWI 8550.5, Hazardous Material Management
26		MWI 8621.1, Mishap and Close Call Reporting and Investigation Program
27		MPR 8715.1, Marshall Safety, Health, and Environmental (SHE) Program
28		MWI 8715.1, Electrical Safety Program
29		MWI 8715.2, Control of Hazardous Energy (Lockout/Tagout) Program
30		MWI 8715.10, Explosives, Propellant, and Pyrotechnics Program
31		MWI 8715.11, Fire Safety Program
32		MWI 8715.12, Safety, Health and Environmental-Finding Tracking System (SHEtrak)

33		MWI 8715.13, Safety Concerns Reporting System (SCRS)
34		MWI 8715.15, Ground Operations Safety Assessment Program
35		MWI 8715.17, Hazardous Operations Readiness Review Program
36		For Construction - Indefinite Delivery Indefinite Quantity (IDIQ) and Blanket Purchase Agreement (BPA) – MSFC Technical Specifications for Repairs and Construction (TSRC)
37		For Construction – Construction of Facilities (CoF) – MSFC Master Specs

APPENDIX C
MSFC EMERGENCY TELEPHONE LIST

[Post at worksite or a designated meeting area where workers gather prior to commencing work or for other activities. The "Emergency Phone List" can also be located in company vehicles if the Contractor does not have a designated meeting area.]

MSFC NETWORK TELEPHONE		OTHER TELEPHONE
AMBULANCE	911	911- Specify at MSFC or 544-4357, Option (Security)
CHEMICAL SPILLS	911	544-4357, Option (Security)
Environmental Engineering Office		544-4246
FIRE	911	876-2117
SECURITY	911	544-4357, Option (Security)
MEDICAL CENTER (bldg 4249)		544-2390

[Identify that you are on MSFC property if using a cell phone and give location, building number, road, intersection, etc. if known.]

TO REPORT UNSAFE, UNHEALTHFUL OR ENVIRONMENTAL CONCERNS

OCCUPATIONAL HEALTH SERVICES	544-2390
ENVIRONMENTAL ENGINEERING OFFICE	544-4246
INDUSTRIAL SAFETY BRANCH	544-0046

TO REQUEST A PERMIT

Welding/Burning/Cutting Permits	544-0046
Inside Test Area	544-7374, 961-1178
CONFINED SPACE PERMITS (call all numbers listed below)	
Occupational Health Services	544-2390
Industrial Safety Branch	544-0046
Inside Test Area	544-7374, 961-1178
Fire Department	876-3437
Digging Permit	544-6759

Company Name:	
Company Emergency Contact:	Phone:
Company Emergency Contact:	Phone:
Company Emergency Contact:	Phone:
Company SHE POC:	Phone:
Competent SHE POC (Alt)	Phone:
Competent Person – Lifting Equip:	Phone:
Competent Person – Excavation/Trench:	Phone:
Competent Person - Scaffold:	Phone:
Competent Person - Rigging:	Phone:
Competent Person:	Phone:
Competent Person:	Phone:

END OF SECTION

SECTION 010650 — ENVIRONMENTAL COMPLIANCE

PART 1 - GENERAL

1.1 SUMMARY

A. This section deals with hazardous waste, stormwater, and green purchasing. Refer to section 01 74 19 for construction waste and demolition.

1.2 REFERENCE

A. The publications listed below form a part of this section to the extent referenced:

1. MPR 1840.4, MSFC Asbestos Program
2. MWI 8540.2 Green Purchasing Program
3. Executive Order 13423 Strengthening Federal Environmental Energy, and Transportation
4. Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance
5. MPD 8500.1, MSFC Environmental Management Policy
6. MPR 8500.1, MSFC Environmental Management Program
7. MPR 8500.2, MSFC Environmental Management System
8. Steel Structures Painting Council (SSPC):

    a. SSPC Technology Guide No. 6 (2004) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations

1.3 SUBMITTALS

A. Submit one copy of Material Safety Data Sheets (MSDS) and Chemical Inventory Worksheet for all hazardous materials brought on site. The contractor shall use MSFC Form 4582 provided by the Government.

B. Inspection Reports: Monthly Submittals (by the 10th for the previous month):

C. Construction Best Management Practices Plan (CBMPP)

1. For construction disturbances less than 1 acre, submit a Site Specific CBMPP using attachment A.
2. For construction disturbances of one acre or greater, the contractor shall obtain a Construction Storm Water Notice of Registration (NOR) on Alabama Department of Environmental Management (ADEM) Form 498. (http://www.adem.state.al (ADEM Forms). The contractor shall prepare and submit the NOR along with a CBMPP to ADEM, and have an approval from MSFC AS10 prior to starting work. Submit within 10 days of receipt a copy of any and all appropriate permits and notices received or granted.

D. Closeout Submittals

1. Submit Stormwater Inspection Records (monthly and daily inspections) at the end of the project.
2. Green Purchasing Report: The contractor shall submit a report listing purchases of items containing recycled or biobased materials on MSFC Form 4510 (MSFC Construction Green Purchasing Reporting Form). The contractor shall include the amount spent on items containing recycled materials or biobased products and amount spent on items that do not contain recycled materials or are not biobased. The accounting shall include the amount spent on all products that meet the EPA (http://www.epa.gov/epaoswer/non-hw/procure/products.htm) guidelines or the USDA guidelines (http://www.biopreferred.gov/ProposedAndFinalItemDesignations.aspx) whether specified or not.

1.4 DEFINITIONS

A. Construction disturbance: Defined in ADEM Regulation 335-6-12-.02 (e).

B. Environmental Policy: "Enabling NASA's mission by providing environmental compliance and stewardship and a safe and healthful workplace."

C. Inspection: Examining satellite accumulation points to ensure compliance with the State of Alabama Regulations. Examining site conditions, records, and plans for compliance.

D. Postconsumer content: A material or finished product that has served its intended use and has been diverted or recovered from waste destined for disposal, having completed its life as a consumer item. Postconsumer materials are part of the broader category of recovered materials.

E. Qualified Credentialed Inspector (QCI) is an operator, operator employee, or operator designated qualified person who has successfully completed initial training and annual refresher Qualified Credentialed Inspection Program (QCIP) training and holds a valid certification from an ADEM approved cooperating training entity.

F. Qualified Credential Professional (QCP) is any staff member of ADEM designated by the Director, a Professional Engineer, an Alabama Natural Resources Conservation Service professional designated by the State Conservationist, or a Certified Professional in Erosion and Sediment Control (CPESC). A QCP includes a registered landscape architect, a registered land surveyor, a Professional Geologist, a registered forester, a Registered Environmental Manager as determined by the National Registry of Environmental Professionals (NREP), and a Certified Professional Soil Scientist (CPSSc) and other ADEM accepted professional designations, certifications, and/or accredited university programs that can document requirements regarding proven training, relevant experience, and continuing education that enable recognized individuals to prepare Construction Best Management Practice Plans (CBMPPs), to make sound professional judgments regarding Alabama National Pollutant Discharge Elimination System (NPDES) rules, planning, design, implementation, maintenance, and inspection of construction sites, receiving waters, Best Management Practices (BMPs), remediation/cleanup of accumulated offsite pollutants from the regulated site, and reclamation or effective storm water quality remediation of construction associated land disturbances, that meet or exceed recognized technical standard and guidelines, and effective industry standard practice. The QCP shall be in good standing with the authority granting the registration or designation.

G. Waste Stream: A generation of a spent/waste hazardous or recyclable material that requires either recovery or disposal in accordance with appropriate environmental, NASA, Federal, State and local laws and regulations.

1.5 EXPLOSIVE ORDNANCE AND CHEMICAL WARFARE MATERIAL PRECAUTION

A. See Section 01 05 90, 1.4.

PART 2 - PRODUCTS

2.1 ACCUMULATION CONTAINERS

A. Hazardous and controlled waste accumulation containers will be provided by the Government. The containers shall be requested by the Contractor three days in advance of the initial need date.

B. The containers will be labeled by the Government.

C. Ensure that the accumulation containers are secured such that the containers shall not be exposed to vehicular traffic.

D. Turn in the containers when ninety percent (90%) of the rated volume of each container is used for liquid waste. Containers of solid waste may be filled to hundred percent (100%).

E. At the time of turn-in, identify if a replacement container is required.

F. Ensure that hazardous and controlled waste are segregated and labeled by type in different accumulation containers.

PART 3 - EXECUTION

3.1 HAZARDOUS WASTE GENERATOR NOTIFICATION AND TRAINING.

A. The Contractor shall designate a person as point of contact (POC) and as many as two alternate people for each hazardous and controlled waste accumulation site.

B. The POCs shall be responsible for maintaining the Contractor's accumulation site in compliance with all applicable Federal, state and local laws and regulations.

C. The Contractor shall attend the first available SHE 101C, "Safety, Health, and Environmental (SHE) Program Construction Awareness" training after initiation of the contract. The training is conducted on site by the Government at no cost to the Contractor.

D. Government personnel will inspect the accumulation site(s) to ensure compliance.

3.2 HAZARDOUS MATERIAL NOTIFICATION AND TRAINING

A. As required in Federal Standard 313, the Contractor shall submit to the Government a Chemical Inventory Worksheet listing the product names and quantities of all hazardous materials brought on site. The Contractor shall maintain a copy of this list at the job site for inspection by the Government. Copies of the MSDSs shall be readily accessible to all Contractor employees at the job site either hard copy or electronic. Contractor shall provide a copy on MSFC Form 4582.

B. The Contractor shall attend the first available SHE 101C, "Safety, Health, and Environmental (SHE) Program Construction Awareness" training after initiation of the contract. The training is conducted on site by the Government at no cost to the Contractor.

C. The Contractor shall ensure that all personnel working in the area are made aware of the chemical hazards associated with chemicals located at the jobsite.

3.3 HAZARDOUS AND CONTROLLED WASTE COLLECTION

A. The Contractor shall notify the Government of wastes being generated. The Government will determine the correct method of disposal.

B. The following types of hazardous and controlled waste are commonly associated with construction projects; however, it is not necessarily an all inclusive list. All wastes shall be collected and placed into accumulation containers for disposal.

1. All fluorescent light ballasts and lamps.
2. High Intensity Discharge (HID) lamps.
3. Free oil liquids and oil filters. Oil rags that are not saturated (no free liquids dripping) shall be disposed as solid waste.
4. Paint, paint thinners, adhesives, etc.
5. Sandblast material from tanks, equipment, and piping.
6. Materials used for cleaning and degreasing of equipment, tanks, and piping.
7. Paint chips from water blasting operation, scraping, sandblasting, grinding, etc. Shall be collected on a daily basis. Materials to be recycled shall be free of loose lead paint chips prior to recycling.
8. Aerosol cans.
9. Process piping system cleaning operations fluids shall be collected and disposed as directed.

C. The Contractor shall adhere to Government guidelines for inspections, collection, and turn-in of waste materials.

D. Asbestos-containing material (ACM) shall be bagged, labeled and handled in accordance with OSHA and EPA regulations and MSFC procedures per MPR 1840.4, "MSFC Asbestos Program". The Contractor shall transport and dispose of ACM at the Redstone Arsenal Landfill (RSAL), unless otherwise approved by the Government. See Section 02 82 00 for additional information.

3.4 EMPTY CONTAINER MANAGEMENT

A. Empty hazardous material containers (5 gallons and larger) shall be turned in to the Government. The Contractor shall ensure the containers are empty using practices commonly employed to remove materials from that type of container such as pouring, pumping, and aspirating.

B. Clean and purge/triple rinse all empty containers as required by the Government.

C. Ensure bungs and/or tops are secured prior to storage/turn-in.

D. Empty containers shall not be stacked more than two high for any size container on pallets.

E. Empty containers that are damaged and will not seal shall be taped over the damaged area or turned upside down to prevent rainwater collection.

F. Empty containers shall be turned in frequently, as determined by the Government.

3.5 CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP)

A. Construction Best Management Practices Plan (**Site disturbing greater than 1 acre**): The Contractor shall prepare, submit, and have approved a site specific CBMPP, prior to work commencing on site. The Contractor will implement the CBMPP throughout the duration of the construction. This CBMPP must be prepared in accordance with ADEM Administrative Code 335-6-12-.21 by a QCP. If a Construction Storm Water Notice of Registration (NOR) from ADEM is required, the prime construction Contractor shall apply for the permit and advertise for a period of seven days by placing the permit application in the legal section of the local newspaper 15 days prior to starting any work at the selected site..

B. Construction Best Management Practices Plan (Site disturbing less than 1 acre): The Contractor shall prepare a Site Specific Construction Best Management Practices Plan (CBMPP) (Attachment A). The Contractor will implement the CBMPP throughout the duration of the contract.

C. Daily Stormwater Inspection Record: The Contractor shall perform daily inspections of hazardous waste containers, hazardous materials containers, empty containers, vehicles and equipment, and erosion and sediment controls. The daily inspection will be documented in a similar format as shown on MSFC Form 4524, Stormwater Inspection Record (available from the Government), or other format acceptable to the Contracting Officer. The inspection documentation will be maintained and available at the site for periodic verification of compliance by the Government and will be submitted to the Government upon completion of construction.

1. Inspections: When no work is being conducted (e.g., weekends, holidays, etc.), no inspection is necessary. The Contractor shall ensure that the site is in compliance with the CBMPP. If the project construction site is greater than 1 acre, inspections shall be performed by a contractor representative that meets the requirements outlined in ADEM Administrative Codes 335-6-12-.02(p) and (q), which states that inspections must be conducted by a QCI or QCP or a person under the direct supervision of a QCP (QCP designee).

2. Daily Stormwater Prevention Inspection. The Contractor shall inspect daily, unless otherwise noted, hazardous waste containers, hazardous material containers, empty containers, vehicles and equipment, and erosion and sediment controls for:

    a. Containers protected from traffic
    b. Containers labeled
    c. Storage area neat and orderly
    d. Spillage from material handling
    e. Containers sealed, during inactivity
    f. Damaged pallets
    g. Damaged containers
    h. Spill cleanup materials available
    i. Containment system in good condition
    j. Containment valves closed
    k. Containment system water managed appropriately
    l. Fluids leaking from vehicles and equipment

D. Monthly Stormwater Inspection Record

1. The Contractor shall perform monthly inspection of erosion and sediment controls for the construction site. The inspection shall be documented in a format acceptable to the Contracting Officer. The inspection documentation shall be maintained and available at the site for periodic verification of compliance by the Government and shall be submitted to the Government upon completion of construction.

2. The Contractor shall inspect erosion and sediment controls for:

    a. No signs of excessive erosion
    b. Erosion controls are effective and in good condition
    c. No sediment buildup in storm water structures (inlets, ditches)

E. Deficiencies and Inspections: Contractor shall take immediate action to correct any environmental findings or non-compliances. Failure to come into compliance or correct a finding to the satisfaction of the contracting officer within 48 hours, from the time when the non-compliance was discovered by the contractor or from the time when the contractor was notified, shall result in the contractor stopping all on-site work at the contractor's sole expense until compliance is achieved as determined by the government and the contracting officer has approved continuation of work. The contractor may submit to the Contracting Officer's Technical Representative (COTR) for approval within the 48 hours an Environmental Recovery Plan detailing day-by-day activities including intermediate protective measures that will be taken in order to come into compliance within a specified recovery period and to forego the stop of work until completion of the approved recovery period.

F. Stockpiles of dirt must be stabilized with temporary or permanent vegetative cover if material is not actively disturbed more than thirteen (13) days per ADEM Admin R. Code 335-6-12-.21(2)5.

3.6 SPILLS OF HAZARDOUS MATERIALS

A. The Contractor shall activate the MSFC Emergency Plan for emergency spills by dialing 911. The contractor may dial 256-544-4357 for non-emergency hazardous material spills that cannot be cleaned up with contractor cleanup material. The Contractor is responsible for costs incurred in cleaning up spills.

B. The Government will determine the correct disposal method for spilled materials.

C. The Contractor shall maintain spill cleanup material for the type of hazardous materials used at the construction site.

3.7 HANDLING, DUST CONTROL, AND DISPOSITION OF LEAD COATINGS

A. Lead-containing material shall be bagged, labeled, and handled in accordance with OSHA and EPA regulations and MSFC procedures per MWI 1840.1, “MSFC Industrial Hygiene Programs”. The Contractor shall transport and dispose of lead-containing material. See Section 02 83 00 for additional information.

3.8 REQUIREMENTS FOR REMOVING LEAD COATINGS - SMALL SCALE / SHORT DURATION

A. Lead-containing material shall be bagged, labeled, and handled in accordance with OSHA and EPA regulations and MSFC procedures per MWI 1840.1, “MSFC Industrial Hygiene Programs”. The Contractor shall transport and dispose of lead-containing material. See Section 02 83 00 for additional information.

3.9 GREEN PURCHASING

A. The Resource Conservation and Recovery Act (RCRA) requires that use of recovered/recycled (recycled) materials in the products to the greatest extent practicable. Additionally, Executive Order 13423 requires (1) the reduced use of chemicals and toxic materials and purchase of lower risk chemicals and toxic materials as well as (2) the expanded purchasing of environmentally sound goods and services, including biobased products. Furthermore, Executive Order 13514 requires that 95% of new contract actions are energy-efficient, biobased, environmentally preferable, non-ozone depleting, contain recycled content, or are non-toxic or less toxic. The Farm Security and Rural Investment Act of 2002 (Farm Bill) requires the purchase and use of biobased products.

B. The Contractor shall determine from the technical specifications what products require recycled biobased content and purchase accordingly.

C. Whenever a product is required to contain recycled material or be biobased by the technical specification but cannot be produced as specified, the Contractor shall notify the COTR, by submitting a product substitution request per the Section 016000 entitled “Product Requirements” with a Contractor-signed letter explaining in detail what suppliers and manufactures were contacted and why the product cannot be produced as specified.

D. Green Purchasing Report: See Section 1.3 D for requirements

E. GREEN PURCHASING WAIVER: The Contractor purchase from the list of products (see Section 1.3 D) if one of the following exceptions applies: 1) Inadequate competition; 2) Unreasonable price; 3) Lack of quality/performance specifications or standards; or 4) Unavailable within a reasonable timeframe.

1. The Contractor shall prepare a request for waiver using MSFC Form 4412, "Green Purchasing Request for Waiver". Include any necessary accompanying documentation, and forward the document to the Government for concurrence and approval (follow instructions on the form). If the waiver is approved, the excepted item is available for purchase. The Government shall keep the original signed waiver. If the waiver is disapproved, the Contractor shall revise the purchase request to include the environmentally preferable product. If a disapproved waiver is disputed, the Contractor shall consult the Office of Center Operations management for resolution. If necessary, the Agency Environmental Executive shall be consulted (per NPR 8530.1) to resolve the waiver dispute.

3.10 ENVIRONMENTAL MANAGEMENT SYSTEM REQUIREMENTS

A. The Contractor shall comply with the MSFC Environmental Management Policy in MPD 8500.1 and procedures and requirements including, but not limited to, MPR 8500.1, "MSFC Environmental Management Program" and MPR 8500.2, "MSFC Environmental Management System."

B. The Contractor shall ensure that their offsite employees and subcontractors (through subcontract requirements or other means) with onsite access are aware of any environmental responsibilities associated with their activities onsite. Failure to comply with environmental policies and procedures may result in damage to the environment and could potentially result in regulatory penalties against NASA and/or the Contractor, and Contractor loss of access to NASA/Marshall facilities.

ATTACHMENT A

CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP)
(For sites disturbing less than 1 acre)

Contract Information

Contractor: _____

Address: _____

Phone: _____

Construction Site Contact Name: _____

Construction Contract Number: NNM_____

General Information: Describe the planned construction project. Include a description of amount of disturbed land, expected duration, and location. Provide a site map or use the site map included on the design drawings detailing the construction site including general drainage areas and gradients, nearby landmarks (buildings, paved areas, etc.), erosion control measures, topography.

Construction Materials: Provide a general list of the types of chemicals, substances that will be used at the construction site.

Erosion and Sediment Controls: Describe any erosion and sediment controls necessary. These controls shall be implemented during the construction period to prevent or control the loss of soil from the construction site. The methods could incorporate structural practices and/or vegetative stabilization. Examples are mulching, checkdams, temporary downdrain structures, sediment barriers, etc.

END OF SECTION

SECTION 01 07 00 — CONTRACTOR QUALITY ASSURANCE/QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This specification sets forth quality assurance/quality control requirements for the provision of materials, equipment, systems, inspections, tests, services, and construction of facilities and site improvements. The quality of work-in-progress and finished work is the responsibility of Contractor line management. These requirements provide for an effective system to ensure that contractual quality requirements and technical criteria are satisfactorily met.

1.2 RELATION TO OTHER CONTRACT DOCUMENTS

A. The requirements of this specification shall be fully complied with in close concert with the detail requirements of the technical specifications and all other contract documents. Overlapping and interfacing contractual requirements shall not result in duplication of Contractor efforts. The quality program shall effectively complement and support functions required by the technical specifications and other contract documents.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 013300, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

A. Preconstruction Submittals: The Contractor shall submit a detailed written statement describing procedures that will be implemented to achieve quality on the project according to the paragraph entitled, "Contractor's Quality Assurance/Quality Control Plan." The plan shall be submitted and approved by the Government prior to Notice to Proceed and describe how the quality requirements of the specifications will be met and address each of the following:

1. Delegation of Contractor's authorized representative responsible for quality assurance/control of contract work.
2. The Contractor's quality assurance/control plan and procedure for accomplishing and reviewing construction methods and controls, fabrication controls, certifications, documentation of quality control operations, inspections, and test records including those required for suppliers and subcontractors. Describe methods to be effected during the procurement cycle (order to deliver) for the selection of construction materials, suppliers, subcontractors, on-site and off-site fabrication and assembly of Contractor- furnished materials and equipment, work procedures, workmanship, and testing to ensure full compliance with plans, specifications, codes, regulatory requirements, and other contract documents.
3. The Contractor's program shall provide for a functional system to document that quality provisions of contract schedules, specifications, and drawings have been performed.
4. Training, certification(s), and re-certification(s) of personnel as required by the specifications.

5. Certification of materials, processes, or equipment as required by the specifications.
6. Qualification of procedures as required by the specifications.
7. Nondestructive testing requirements as required by the specifications.
8. Identification of independent certifying and testing laboratories to be used.

B. Records: Records shall include all quality control data; factory test plans/results, manufacturer's certifications, receiving inspections, deficiency correction reports; construction deficiency reports (CDR); training/certifications; letter of authority or delegation; and routine technical test plans/results, i.e., hydrostatic, electrical continuity, grounding, welding, line cleaning, etc. Quality records shall be available for examination upon request by the designated Government representatives. Quality control records shall be maintained in a central on-site location. Maintenance of quality control records shall not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification. All quality records shall be turned over to the Government's designated representatives as a file of record at contract completion.

1.4 QUALITY ASSURANCE

A. Qualifications: When approval or certification of special processes, operating personnel, and special equipment or procedures is required by the specifications, the Contractor shall obtain necessary approvals or certifications prior to starting the work.

B. Management and Organization: Contractor shall ensure effective execution of quality assurance/quality control functions and provide competent personnel with experience in quality assurance/quality control functions to provide supervision, inspection, and testing. Contractor shall be responsible for each of his suppliers and subcontractors. Contractor shall provide quality assurance oversight of suppliers and subcontractors and ensure that each provides effective quality control in the execution of their work. The program shall encompass management and supervisory actions that affect quality of all work-in-progress and finished construction work. The individual designated to direct the program shall report to the Contractor's management and shall have the necessary authority to discharge his responsibilities.

C. Identification and Data Retrieval: The Contractor shall have an identification and data retrieval system. Records, drawings, submittals, and equipment shall be identified to reference the following:

1. Contract Number
2. Contract Specification Number
3. Contract Drawing Number
4. Submittal Document Number
5. Contract Change Number
6. Contractor's Drawing Number System

D. Procurement: The Contractor shall be responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality requirements. The Contractor shall ensure that his purchase documents include:

1. The basic quality requirements, standards, drawings, and specifications called out in the contract specifications.

2. Inspection and Test Characteristics.
3. Inspection and Test Records.
4. Operational and Maintenance (O&M) manuals, Instructions, Certifications of Compliance, and such other data as may be required by the specification.
5. Preservation, packaging, shipping directions.

E. When Government source inspection is required on a Contractor's purchase, the purchase document shall include the following statement: “All work on this order is subject to inspection and testing by the Government at any time and place. The Contracting Officer shall be notified immediately upon receipt of this order. The Contracting Officer shall be notified 72 hours in advance of the time articles or processes are ready for inspection or test."

F. Procurements that do not require Government source inspection shall include the following statement: "The Government reserves the right to inspect any or all of the materials included on this order at the Contractor's plant."

G. Required Government source inspections will be determined by the Contracting Officer. Government source inspections shall not replace Contractor inspections or relieve the Contractor of his responsibility for ensuring quality procurements and records verifying quality control activities.

H. Receiving Inspection System: Contractor shall maintain a receiving inspection system that ensures procured materials and equipment are inspected and tested as required by specifications, drawings, and approved submittal documents. Shipping/receiving inspection records will accompany each procurement delivery to the construction site. Maintain records of receiving inspections at the construction site by the Contractor. Records shall show defects, discrepancies, dispositions, and waivers, including evidence of Government source inspection.

I. Nonconforming Articles and Material Control: The Contractor shall control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations.

1. Contractor shall prepare a construction deficiency report for each instance comprising:
   a. A unique and traceable number.
   b. Identification of the nonconforming article or material.
   c. A description of the nonconformance and the applicable requirement.
   d. Cause or reason for the nonconformance.
   e. Remedial actions taken or recommended.
   f. Disposition of the nonconforming article or material.
2. The Contractor shall identify, mark, and segregate each nonconforming article for removal from the work area to prevent inadvertent use.
3. The Contractor shall monitor and correct deficient operations.

J. Fabrication, Process, and Work Control: The Contractor's procedures and controls shall be derived from stated requirements in contract specifications and drawings. The Contractor shall establish in-process inspections and ensure compliance with quality requirements that are not readily detectable or measurable by inspection and test of finished elements. Special processes may include, but are not limited to, concrete placement, piping system cleaning, plating, anodizing, nondestructive testing, welding, and soldering.

K. Drawings and Change Control: Drawing-control system shall be maintained to provide revised drawings and change distribution and removal of obsolete drawings from work areas. Changes involving interface with other work areas, or affecting articles or materials controlled by others shall be controlled by the Contractor. This system shall be integrated with the document requirements of the contract. Drawing changes shall be clearly specified. Accomplished changes shall be clearly identified and associated drawings shall be revised. Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

L. Quality Inspections: Government Inspections: Work performed under the general direction of the Contracting Officer will be subject to inspection by authorized representatives. No representative is permitted to change specifications or drawings without written authorization of the Contracting Officer. Government in-process and end-item inspections may, at the Government's discretion, be performed on site and/or at the Contractor's or subcontractor's facility by Government representatives. Government shall be notified with sufficient advance notice of Contractor work plans which will cover up or make inaccessible previously installed work which may require Government inspection, i.e., backfilling or encasing of any underground utility, concrete placement, etc. Failure to provide such notification may require the work be uncovered to inspect the work. Uncovering and restoration of the work shall be at the Contractor's expense. The Contractor's quality assurance/control program is subject to continuous evaluation, review, and verification by the Contracting Officer. The Contractor will be notified in writing of any noncompliance area and will be given 5 days to correct identified deficiencies.

M. Contractor's Quality Inspections: Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections and tests. Contractor shall ensure that nonconforming products are discovered, documented, and controlled. Procedures eliminating future deficiencies shall be implemented. Contractor's quality assurance system shall include the following:

1. Single Contractor's representative responsible for on-site/off-site communication and operation of the inspection program.
2. Purchasing control system documenting project procurement to drawings, specifications, and approved submittals.
3. Receiving inspection system documenting inspections for each procurement verifying material and equipment is compliant with plans and specifications.
4. Documentation for handling and disposing of nonconforming components and materials.
5. Inspection records as required for each specific section of the specification and drawings.
6. Identification of test(s) to be performed, test procedures, test plans/reports, records, and independent organizations used.
7. Documenting and maintaining certification or re-certification of procedures, personnel, and equipment.
8. Management of Government-furnished equipment, components, and materials.
9. Calibration of gages, tools, measuring instruments, and independent laboratories used and all associated documentation.

N. The Contractor shall establish his own system of scheduled or random sample inspections and audits to ensure objectives are met.

O. Manufacturer's Field Services: Responsibility for Inspection and Testing: Contractor is responsible for the performance of inspections and tests. Each shall be recorded. The

Contractor shall utilize independent inspection and testing laboratories or services that are acceptable to the Government. Tests of construction materials shall be accomplished by the Contractor utilizing the services of an acceptable independent testing laboratory.

P. Inspection and Test Records: The Contractor shall provide on-site records of each inspection and test performed throughout the life of the contract. Records shall include, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, test plans/reports, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Q. Records of in-process inspections and controls away from the job site may be used as evidence of quality of materials/work and, at the discretion of the Government, may reduce further inspection or testing after delivery to the job site.

R. The Contractor shall ensure each record is identified and traceable to specific requirements in the specifications and drawings.

1.5 HANDLING AND STORAGE

A. The Contractor shall provide controls and procedures which meet requirements of each section of the specifications. The Contractor shall include documentation with each shipment. The data shall consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

1.6 SEQUENCING AND SCHEDULING

A. Contractor shall notify the Government a minimum of 48 hours prior to scheduled inspections and tests. Contractor shall provide 24-hour notice to the Government of the date when the contract work will begin at the site. When Contractor suspends work for 5 days or longer prior to completion, he shall notify the Contracting Officer. Work shall not suspend nor resume without notification of the Contracting Officer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 24 04 - PRECONSTRUCTION SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section identifies the documents required to be submitted and approved prior to the Pre-Construction Conference.

1. Safety and Health Plan shall be submitted in accordance with Section 013300 “Submittals” and Section 010610 in sufficient detail to shown full compliance with the contract documents.
2. Quality Control Plan shall be submitted in accordance with Section 013300 “Submittals” and Section 014000 in sufficient detail to shown full compliance with the contract documents.

B. This Section identifies the documents required to be submitted at the Pre-Construction Conference.

1. Subcontractor List shall be submitted and shall conform to the requirements in Part 2 below.
2. Waste Management Plan shall be submitted in accordance with Section 017419 “Construction Waste management and Disposal”.

1.2 SUBMITTALS

A. Subcontract List: Submit three copies and a CD containing an electronic copy of the subcontract list at the Preconstruction Conference

PART 2 - PRODUCTS

2.1 SUBCONTRACTOR LIST

A. Submit a list of subcontractors 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. Use CSI Form 1.5A or similar form and include the following information in tabular form:

1. Company name, address, telephone number, point of contact and email of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 013200 — PROJECT SCHEDULES

PART 1 - GENERAL

1.1 SUMMARY

1.2 This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work. Upon contract award, the Contractor shall begin preparation of the Contractor's construction schedule, and critical path submittals necessary to meet the Contractor's construction schedule.

1.3 DEFINITIONS

A. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains the least float.

B. Float: The measure of leeway in starting and completing an activity.

1.4 SUBMITTALS

A. Contractor's Baseline Construction Schedule: The Contractor's construction schedule consists of a bar chart identifying the start and finish for all tasks shown in the schedule. When NTP is given, the Contractor shall submit within 30 calendar days of the NTP, a "baseline schedule" changing only the projected NTP date to the actual NTP date on the initial schedule. Subsequent construction schedules shall be submitted every 30 calendar days thereafter, and be chronologically labeled starting with the letter "A". Submit three (3) paper copies and a CD containing the electronic file compatible with "Microsoft Project".

B. Monthly Schedule Updates. The Contractor shall update the previously approved schedule monthly and submit three (3) paper copies and a CD containing the electronic file compatible with "Microsoft Project". Each update shall include a complete revision of all activities and milestones and other and data as needed. Redlined updates will only be acceptable at the weekly meetings. As a minimum, each update shall include revised dates for the following:

1. All tasks started or completed.
2. All tasks with missed start or finish dates.
3. Milestones completed, or missed.
4. Revised percent complete for all active tasks.
5. Revised submittal dates for all submittals
6. Approved changes.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. The Contractor's construction schedule consists of a bar chart identifying the various tasks to be accomplished. Task relationships with predecessors and successors shall be included in the bar chart. Prepare the schedule to ensure consistency of the tasks with each other, the submittals schedule, payment requests, and other required schedules and reports. The schedule shall reflect construction site activities and supporting activities, such as submittal reviews, major material orders and delivery, fabrication, user activities and key milestones, etc., as well as activities at the request of the Contracting Officer.

B. Bar Chart: The Contractor shall:

1. Use a recognized computer software program to prepare the schedule.
2. Prepare the schedule in the form of a bar chart utilizing a format acceptable to the Contracting Officer.
3. Prepare a schedule with sufficient detail to facilitate the Contractor's control of the job and to allow the Contracting Officer to readily follow progress of all portions of the work.
4. Depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished.
5. Indicate project activities beginning with contract award through actual project close out date, in an organized, logical, and consistent order.
6. Show activities by major headings for primary work activities. Each major heading shall show all activities. All activities shall be shown in sufficient detail to track the progress of the task. Typically, activities shall have durations of 30 work days or less. All activities and milestones shall have at least one predecessor and/or one successor activity and/or milestone.
7. The critical path shall be clearly delineated on the display. When milestone dates are included in the Contract they shall be clearly indicated on the display.
8. As a minimum, the following detailed activities and milestones shall be included:

    a. Milestones: Contract Award, NTP, field work, phased work start and finish, final inspection, project planned completion, contract completion date.
    b. Specific activities: Bonding. Mobilization, Demobilization, Punch-list, Cleanup, and Final close out submittals.
    c. Specific project on-site construction tasks of all activities.
    d. Specific off-site tasks necessary to achieve specific project site activities.
    e. All utility outages and road crossings/closures.
    f. Submittal review activity by the Government, as specified herein and its subparagraphs, for each submittal required. Furthermore, each of these activities shall be linked as a predecessor to all affected tasks.
    g. Major equipment and material procurement including delivery (submittal handling shall be separate per above).
    h. Contract required notices to the Government which affect any task/activity (show as a one-day duration) and shall be entitled "Notice," followed by a brief description.

9. Each line item will show the scheduled percentage complete for that given contract performance period.
10. The estimated cost for each activity on the chart.

PART 3 - EXECUTION

3.1 SCHEDULING AND DETERMINATION OF PROGRESS

A. Independent of partial payments made pursuant to Standard Form 1422, Section I (Payments Under Fixed-Price Construction Contracts), Provision No. 52.232-5, there shall be no payment to exceed 90 percent of the actual cost of materials or equipment that is not installed and no partial payments will be made for materials or equipment not on site. The effort shown toward installation of this equipment will be considered by the Contracting Officer in determining the amount of partial payment.

B. As-Built Drawings: In order to minimize the time for final payment at the completion of the project, the Contractor shall update the as-built drawings every month with the Contracting Officer's authorized representative. This update will be a part of "the monthly request for payment" and payment -- or a portion of the payment, including final payment -- may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

3.2 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Bar Chart: The bar chart will be utilized for progress payments.

B. Construction Schedule Approval: Government approval of the construction schedule is in general terms of overall compliance. The Government may question and seek clarification of certain details of the schedule to ensure contract compliance. The Contractor shall make such clarifications within 5 working days. The Contractor retains full responsibility for creation and maintenance of the schedule as well as its contents, logic, and use to fulfill all contract obligations.

C. Requests for Time Extensions: In the event the Contractor requests an extension of the contract completion date, he shall furnish a justification for delay, a revised project completion date, and supporting evidence as the Contracting Officer may deem necessary for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof of delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is obligatory to any approvals.

1. Justification for Delay: The Contractor shall submit a justification for each request for a change in the contract completion date, based upon the most recent approved schedule at the time of the Notice to Proceed or constructive direction issued for the change. The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

    a. A list of affected activities, with their associated project schedule activity number.
    b. A brief explanation of the causes of the change.
    c. An analysis of the overall impact of the changes proposed.
    d. A sub-network of the affected area.
    e. Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

D. Directed Changes: If Notice to Proceed (NTP) is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work. All logic changes pertaining to notice to proceed on change orders, change orders to be incorporated into the schedule, Contractor proposed changes in work reference, correction to schedule logic for out-of-sequence progress, lag duration, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

E. Float off the critical path may be used at the Contractor’s discretion. However, use of float on the critical path shall be coordinated with the Government at each weekly project meeting. The Government reserves the right to utilize at its discretion use of float created by the Government acceleration of activities or milestones such as early GFE delivery, use of facilities or space, and early submittal review.

END OF SECTION 013200

SECTION 013300 — SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

This Section includes administrative and procedural requirements for all project submittals required by the individual Specification Sections.

PART 2 - PRODUCTS

2.1 SUBMITTALS

A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents.

1. Drawing Preparation: Include the following information, as applicable:

   a. The job name, which shall be the general title of the contract drawings.
   b. The date of the drawings and revisions.
   c. Name of Contractor.
   d. Name of Subcontractor.
   e. The name of the item, material, or equipment detailed thereon.
   f. Dimensions.
   g. Identification of products.
   h. Fabrication and installation drawings.
   i. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   j. Shopwork manufacturing instructions.
   k. Templates and patterns.
   l. Schedules.
   m. Design calculations.
   n. Compliance with specified standards.
   o. Notation of coordination requirements.
   p. Notation of dimensions established by field measurement.

2. Drawing Format: Drawing submittals shall be prepared using computer interactive graphics and presented on sheets, not less than 11 by 17 inches nor larger than 30 by 42 inches in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawings shall have dark lines on a white background. Drawings shall be numbered in logical sequence. The Contractor may use his own number system. Each drawing set shall contain identification of the transmittal number, specification section or contract number or title. A blank space, no smaller than 4 inches by 4 inches, shall be reserved on the right hand side of each sheet for the Government disposition stamp.

3. Drawings Submittals: Five prints of each drawing shall be submitted. Three prints, marked with review notations will be returned to the Contractor.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

1. Product Data Preparation: Include the following information, as applicable:
   a. Manufacturer's product specifications.
   b. Standard color charts.
   c. Manufacturer's catalog cuts.
   d. Wiring diagrams showing factory-installed wiring.
   e. Printed performance curves.
   f. Operational range diagrams.
   g. Mill reports.
   h. Standard product operating and maintenance manuals.
   i. Compliance with recognized trade association standards.
   j. Compliance with recognized testing agency standards.
   k. Application of testing agency labels and seals.
   l. Notation of coordination requirements.
   m. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

      1) Preparation of substrates.
      2) Required substrate tolerances.
      3) Sequence of installation or erection.
      4) Required installation tolerances.
      5) Required adjustments.
      6) Periodic maintenace requirements
      7) Recommendations for cleaning and protection.

2. Product Data Format: Required data submittals for each specific material, product, unit of work, or system shall be collected on an individual submittal and marked for choices, options, and portions applicable to the submittal. Mark each copy of each submittal to show which products and options are applicable. All options not marked out shall be considered as included. Marking of each copy of product data submitted shall be identical. Partial submittals will not be accepted.

3. Each Product Data Submittal: Five complete sets of indexed and bound data shall be submitted. Three sets marked with review notations will be returned to the Contractor.

C. Samples: Prepare physical units of materials or products, including the following:

1. 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.

2. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified,

and physically identical with the 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.

3. Sample Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Government's sample where so indicated. Attach label on unexposed side that includes the following:

   a. Name of project
   b. Name of Contractor
   c. Material or equipment
   d. Place of origin
   e. Name of producer and brand
   f. Specification Section to which sample applies
   g. Samples of furnished material shall have additional markings that will identify them under the finished schedules.

4. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:

   a. Size limitations.
   b. Compliance with recognized standards.
   c. Availability.
   d. Delivery time.

5. Samples Format: Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish, pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range (not less than 3 units), shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

6. Sample Submittals: One set of identified samples shall be submitted. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Contracting Officer. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to the Contractor. Samples that are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation. Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical

sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

D. Coordination Drawings: Contractor to submit to COTR for approval coordination drawings of all ductwork, including equipment rooms, shafts, hallways, and especially congested areas and areas with possible conflicts. No installation shall proceed without COTR stamped approval of coordination drawings. Submittal to reflect space requirements coordinated with other trades such as Electrical, Plumbing, Mechanical and Structural. Prior to submission to COTR, coordination drawings to have signatory approval of all major trades which occupy ceiling space (HVAC, plumbing, piping, sprinkler, and electrical), to substantiate adequate coordination as to space, accessibility and to ensure no conflict exists between contractors..

1. Indicate relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. The General Contractor shall be responsible for coordination between trades and shall stamp and sign the duct drawings to substantiate that the coordination has been accomplished. Water piping and conduit shall give way to ducts.

E. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product.
2. Number and name of room or space.
3. Location within room or space.

F. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Prepare 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.

G. Contractor’s Construction Schedule: Comply with requirements in Section 013200 "Project Schedules."

H. Submittals Schedule: Comply with requirements in Specification Section "012404."

I. Subcontract List: Comply with requirements Specification Section "012404"

J. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

K. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.

L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and

Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

M. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

N. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

O. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

P. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements. Reports must be signed by authorized representative of the testing agency.

Q. Preconstruction Test Reports: Prepare 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. Reports must be signed by authorized representative of the testing agency.

R. Compatibility Test Reports: Prepare 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. Reports must be signed by authorized representative of the testing agency.

S. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, 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. Reports must be signed by authorized representative of the testing agency.

T. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. 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. Reports must be signed by authorized representative of the testing agency.

U. Factory Test Reports: Prepare written reports of tests performed by the manufacturer as indicated in individual Specification Sections

V. Operations and Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "Closeout Procedures” and “Operation and Maintenance Data."

W. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service representative making report.

2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

X. Warranties: Provide Manufacturers warranty as indicated in individual Specification Sections

Y. Product Closeout Submittals Comply with requirements in Division 1 Section "Closeout Procedures”

PART 3 - EXECUTION

3.1 CONTRACTOR

A. All submittals shall be verified for compliance with the Contract Documents and signed by the contractor.

B. No work may begin or materials be ordered for any item, until a submittal is approved and returned to the contractor.

C. Operation and Maintenance Data: For VFDs. All installed devices and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section “Operation and Maintenance Data”, include the following:

1. Routine maintenance requirements for VFDs and all installed components.
2. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.

D. Resubmittals shall:

1. Respond to each of the Architect/Engineer’s previous submittal review comments.
2. Clearly identify each change that differs from the previous submittal. Cloud changes made to drawings. Changes that are made and not identified will not be considered.

3.2 SUBMITTAL REQUIREMENTS

A. Each submittal shall reference drawing number, Specification Section and paragraph pertaining to the submittal and fully describe the submittal item.

B. The numbering system used (on the transmittal form) for transmission and tracking of submittals shall be provided by the Government and used by the Contractor. The submittal number is composed of the Specification Section number followed by a hyphen, and the numerical order of each submission beginning with 001. Revisions and resubmittals will be numbered chronologically thereafter.

C. Transmittal Form: All transmittals submitted to the Government shall be submitted using MSFC Form 4233. All data fields on the form shall be completed and the form signed by the Contractor. Incomplete submittals will be returned to the Contractor without Government review. Each transmittal form shall transmit items relative to one Specification Section. Data pertaining to that Specification Section may be transmitted together, unless required to be submitted as an individual "item." An item is an individual piece recognized by the type of data being submitted. Examples in general of acceptable individual submittal transmittals include:

a. Groups of valves of different sizes. A submittal would allow that all of the information pertaining to those valves could be listed and submitted on one submittal transmittal.
b. Structural drawings and calculations for individual structures.
c. Electrical lighting troffers, ballast, bulbs, and lenses along with installation instructions and certificates of compliance.
d. Air handlers of the same type.
e. Submittals can list one individual piece pertaining to specific data, such as one valve on one submittal and one instruction manual on another, etc.

D. Product Selection: Highlight, circle, or otherwise identify the specific item selected for use on the project. Include manufacturer, model, size (where applicable) and options.

E. Deviations: Deviations from the specific product options in the Contract Documents shall be highlighted, circled, or otherwise identified on submittals. Failure to point out deviations may result in the Government rejection and requiring removal of such work at no additional cost to the Government.

F. Substitutions: Indicate if product is a substitution and comply with Specification Section 01 60 00. Failure to point out substitutions may result in the Government rejection and requiring removal of such work at no additional cost to the Government

G. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. The Government reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

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.

H. Submittal Quantities: Submit five copies of all submittals unless directed otherwise by the COTR.

3.3 GOVERNMENT'S REVIEW

A. General: The Government will not review submittals that do not bear Contractor's signature and will return them without action. The Government will review submittals and provide pertinent notation within 28 calendar days. The 28-day review clock shall start the day after submittals are received by the Government.

1. Approved Submittals: Approval of the submittals by the Contracting Officer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. The Contractor shall be responsible for the dimensions and design of connection details and construction of work. If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved

2. Resubmittals: For submittals requiring resubmittal, the Contractor shall make corrections required by the Contracting Officer and resubmit within 14 calendar days of receipt. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or Specifications, notice as required under the clause entitled "Changes" shall be given to the Contracting Officer.

B. Review Notations: Submittals will be returned to the Contractor with the following notations:

1. Submittals marked "Approved (APR)" authorize the Contractor to proceed with the work covered.
2. Submittals marked "Approved as Noted (AAN)" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections.
3. Submittals marked "Approved Except as Noted (AEN)" require the Contractor to make a resubmittal for those items that are noted to NOT be in compliance with the contract requirements. Contractor shall obtain an approval for all aspects of the submittal before the depicted work can begin.
4. Submittals marked "Rejected (REJ)" indicate noncompliance with the contract requirements and shall be resubmitted with appropriate changes prior to proceeding with any work. .

C. Sample Approval: The Contractor shall furnish, for the approval of the Contracting Officer, samples required by the Specifications or by the Contracting Officer.

1. Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

2. Materials and equipment incorporated in the work shall match the approved samples. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

3. Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. The Government reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.

4. Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will

automatically void previous approvals. The Contractor shall replace such materials or equipment to meet contract requirements.

5. Approval of the Contractor's samples by the Contracting Officer shall not relieve the Contractor of his responsibilities under the contract.

END OF SECTION 013300

MASTERWORKS SUBMITTAL LOG

PROJECT: REVITILIZED BUILDING MECHANICAL SYSTEMS (4755)
OWNER:

PROJECT NO: NAS8-NNM12AA49C/GMC-02: FAC-M5057
CONTRACTOR:

DATE REC'D.	SPECIFICATION SECTION NO.	SUBMITTAL ITEM	Review and Approval Required by NASA	NO. RECEIVED	OTHER REVIEWER					ACTION				DATE RETURNED	COPIES TO			
					DATE SENT	FIRM	NO. COPIES	DUE DATE	DATE REC'D.	APPROVED	APPROVED AS NOTED	REVISE AND RESUBMIT	NOT APPROVED		CONTRACTOR	OWNER	FIELD	FILE
	010590	**SPECIAL CONDITIONS**																
		Contractor's E-mail Address and Emergency Contact Information																
		Photographs of Temporary Structures																
	010610	**GENERAL SAFETY AND ENVIRONMENTAL HEALTH REQUIREMENTS**																
		Safety Plan																
		Reports MSFC Form 4371																
	010650	**ENVIRONMENTAL COMPLIANCE**																
		Material Safety Data Sheets																
		MSFC Form 4582 – Chemical Inventory Worksheet																
		Monthly Inspection Reports																
		MSFC Form 4510 – Green Purchasing Report																
	010700	**CONTRACTOR QUALITY ASSURANCE/QUALITY CONTROL**																
		Contractor's Quality Assurance/Quality Control Plan																
		Records																
	012404	**PRECONSTRUCTION SUBMITTALS**																
		Submittals Schedule																
		Subcontract List																
	013200	**PROJECT SCHEDULES**																
		Baseline Construction Schedule																
		Monthly Schedule Updates																
	013550	**ASBESTOS PROCEDURES**																
		Training Documentation																
		Medical Examinations																
		Contractor Licenses/Certifications																
		Asbestos Removal Plan																
		ADEM Notification																
	017310	**CUTTING AND PATCHING**																
		Cutting & Patching Proposal																
	017419	**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**																
		Waste Reduction Final Report																
		Recycling & Processing Facility Records																
		Landfill and Incinerator Disposal Records																
		Waste Reduction Progress Reports																
	017700	**CLOSEOUT PROCEDURES**																
		As-Built Drawings																
		Operations and Maintenance Data																
		Warranty																
	017820	**OPERATION AND MAINTENANCE DATA**																
		Operations and Maintenance Manuals																

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	018200	**DEMONSTRATION AND TRAINING**																
		Instruction Program																
		Qualification Statements																
		Demonstration and Training DVD																
	019113	**GENERAL COMMISSIONING REQUIREMENTS**																
		Prefunctional Checklists																
		Functional Performance Verifications																
		Commissioning Plan																
		Commissioning Record																
	022200	**SELECTIVE DEMOLITION**																
		Proposed Sequence of Operations																
	033000	**CAST-IN-PLACE CONCRETE**																
		Product Data																
		Design Mixtures																
		Steel Reinforcement Shop Drawings																
		Materials Certifications																
	078413	**PENETRATION FIRESTOPPING**																
		Product Data																
		Shop Drawings																
	079000	**JOINT SEALANTS**																
		Product Data																
		Samples																
		Testing Results																
		Manufacturer's Installation Instructions																
		Warranty																
	093013	**CERAMIC TILING**																
		Product Data																
		Shop Drawings																
		Samples for Initial Selection																
		Samples for Verification																
	095113	**ACOUSTICAL TILE CEILINGS**																
		Product Data																
		Verification Samples																
	099123	**INTERIOR PAINTING**																
		Product Data																
		Samples for Initial Color Selection																
		Samples for Verification																
	220517	**SLEEVES AND SLEEVE SEALS**																
		Product Data																
	220518	**ESCUTCHEONS**																
		Product Data																
	220519	**METERS AND GAGES**																

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		Product Data																
		Product Certificates																
		Operations & Maintenance Data																
	220523	**GENERAL-DUTY VALVES FOR PLUMBING PIPING**																
		Product Data																
	220529	**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**																
		Product Data																
		Welding Certificates																
	220719	**PLUMBING PIPING INSULATION**																
		Product Data																
		Shop Drawings																
	221116	**DOMESTIC WATER PIPING**																
		Product Data																
		Field Quality-Control Reports																
		System Purging & Disinfecting Activities Report																
	221123	**DOMESTIC WATER PUMPS**																
		Product Data																
	221316	**SANITARY WASTE AND VENT PIPING**																
		Product Data																
		Shop Drawings																
		Field Quality-Control Reports																
	223300	**ELECTRIC, DOMESTIC-WATER HEATERS**																
		Product Data																
		Shop Drawings																
		Source Quality-Control Reports																
		Warranty																
		Wiring diagrams																
		Operations & Maintenance Manuals																
	22421313	**COMMERCIAL WATER CLOSETS**																
		Product Data																
		Shop Drawings																
		Operations & Maintenance Manuals																
	22421316	**COMMERCIAL URINALS**																
		Product Data																
		Shop Drawings																
		Operations & Maintenance Manuals																
	224216.13	**COMMERCIAL LAVATORIES**																
		Product Data																
		Shop Drawings																
		Operations & Maintenance Manuals																

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	230517	**SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**																
		Product Data																
	230518	**ESCUTCHEONS FOR HVAC PIPING**																
		Product Data																
	230519	**METERS AND GAGES FOR HVAC PIPING**																
		Product Data																
		Wiring diagrams																
		Operations & Maintenance Manuals																
	230523	**GENERAL-DUTY VALVES FOR HVAC PIPING**																
		Product Data																
	230529	**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**																
		Product Data																
		Shop Drawings																
		Delegated-Design Submittal																
		Welding Procedure Specifications																
		Welding Procedures Qualifications Records																
		Welders Qualifications Reports																
	230548.13	**VIBRATION CONTROLS FOR HVAC**																
		Product Data																
		Shop Drawings																
		Delegated-Design Submittal																
		Coordination Drawings																
		Qualification Statements																
		Welding Procedure Specifications																
		Welding Procedures Qualifications Records																
		Welders Qualifications Reports																
	230553	**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**																
		Product Data																
		Samples																
		Equipment Label Schedule																
		Valve Numbering Scheme																
		Valve Schedule																
	230593	**Testing, Adjusting & Balancing**																
		Qualifications																
		Testing & Balancing Plan																
		Testing & Balancing Report																
	230713	**DUCT INSULATION**																
		Product Data																
		Shop Drawings																
		Samples																

MASTERWORKS SUBMITTAL LOG

PROJECT: REVITILIZED BUILDING MECHANICAL SYSTEMS (4755)
OWNER:

PROJECT NO: NAS8-NNM12AA49C/GMC-02: FAC-M5057
CONTRACTOR:

DATE REC'D.	SPECIFICATION SECTION NO.	SUBMITTAL ITEM	Review and Approval Required by NASA	NO. RECEIVED	OTHER REVIEWER					ACTION				DATE RETURNED	COPIES TO			
					DATE SENT	FIRM	NO. COPIES	DUE DATE	DATE REC'D.	APPROVED	APPROVED AS NOTED	REVISE AND RESUBMIT	NOT APPROVED		CONTRACTOR	OWNER	FIELD	FILE
	230716	**HVAC EQUIPMENT INSULATION**																
		Product Data																
		Shop Drawings																
		Samples																
	230719	**HVAC PIPING INSULATION**																
		Product Data																
		Shop Drawings																
		Samples																
	230900	**HVAC INSTUMENTATION AND CONTROLS Cx**																
		Product Data																
		Shop Drawings																
		Wiring diagrams																
	230923	**DIRECT DIGITAL CONTROL AND UTILITY CONTROL SYSTEM Cx**																
		Product Data																
		Shop Drawings																
		Warranty																
		Wiring diagrams																
		Sequence of Operations																
		As-Builts																
		Test Plans, Trends and Test Reports																
		Manufacturer's Instructions																
		Operations & Maintenance Manuals																
		Qualifications Data																
		Training Materials																
	231123	**FACILITY NATURAL-GAS PIPING**																
		Product Data																
		Shop Drawings																
		Product																
		Delegated-Design Submittal																
		Coordination Drawings																
		Qualification Statements																
		Welding Certificates																
		Field Quality-Control Reports																
	232113	**HYDRONIC PIPING**																
		Product Data																
		Qualification Statements																
		Field Quality-Control Reports																
		Welding Procedure Specifications																
		Welding Procedure Qualifications Records																
		Welding Qualification Reports																
	232116	**HYDRONIC PIPING SPECIALTIES**																

MASTERWORKS SUBMITTAL LOG

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					DATE SENT	FIRM	NO. COPIES	DUE DATE	DATE REC'D.	APPROVED	APPROVED AS NOTED	REVISE AND RESUBMIT	NOT APPROVED		CONTRACTOR	OWNER	FIELD	FILE
		Product Data																
		Operations & Maintenance Manual																
	232123	**HYDRONIC PUMPS**																
		Product Data																
		Shop Drawings																
		Operations & Maintenance Manual																
	233113	**METAL DUCTS**																
		Product Data																
		Shop Drawings																
		Field Quality-Control Reports																
	233300	**AIR DUCT ACCESSORIES**																
		Product Data																
		Shop Drawings																
	233416	**CENTRIFUGAL HVAC FANS**																
		Product Data																
		Shop Drawings																
		Coordination Drawings																
		Field Quality-Control Reports																
		Operations & Maintenance Manuals																
	233433	**AIR CURTAINS**																
		Product Data																
		Shop Drawings																
		Operations & Maintenance Manuals																
		Warranty																
		Wiring diagrams																
		Source Quality Control Reports																
	233600	**AIR TERMINAL UNITS**																
		Product Data																
		Shop Drawings																
	233713	**DIFFUSERS, REGISTERS, AND GRILLES**																
		Product Data																
		Source Quality-Control Reports																
	234100	**PARTICULATE AIR FILTRATION**																
		Product Data																
		Shop Drawings																
		Wiring diagrams																
		Operations & Maintenance Manuals																
	237314	**MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS**																
		Product Data																
		Source Quality Control Reports																
		Field Quality Control Reports																

MASTERWORKS SUBMITTAL LOG

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		Operations & Maintenance Manuals																
	238126	**SPLIT-SYSTEM AIR-CONDITIONERS**																
		Product Data																
		Shop Drawings																
		Field Quality-Control Reports																
		Warranty																
		Operations & Maintenance Manuals																
	238216	**AIR COILS**																
		Product Data																
		Shop Drawings																
		Operations & Maintenance Manuals																
		Field Quality Control Reports																
	238239.16	**PROPELLER UNIT HEATERS**																
		Product Data																
		Shop Drawings																
		Field Quality-Control Reports																
		Operations & Maintenance Manuals																
	260501	**ELECTRICAL TESTING**																
		Test Reports																
	260519	**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**																
		Product Data																
	260526	**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**																
		Product Data																
		Field Quality-Control Reports																
		Operation & Maintenance Data																
	260529	**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**																
		Product Data																
		Shop Drawings																
	260533	**RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**																
		Product Data																
		Shop Drawings																
	260544	**SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**																
		Product Data																
	262416	**PANELBOARDS**																
		Product Data																
		Shop Drawings																
		Operation & Maintenance Data																
	262726	**WIRING DEVICES**																

MASTERWORKS SUBMITTAL LOG

PROJECT: REVITILIZED BUILDING MECHANICAL SYSTEMS (4755)
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		Product Data																
		Shop Drawings																
		Field Quality-Control Reports																
		Operation and Maintenance Data																
	262813	**FUSES**																
		Product Data																
		Operation and Maintenance Data																
	262816	**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**																
		Product Data																
		Shop Drawings																
	262923	**VARIABLE FREQUENCY DRIVES**																
		Product Data																
		Shop Drawings																
		Qualification Data																
		Field Quality-Control Test Reports																
		Operation and Maintenance Data																
	265100	**INTERIOR LIGHTING**																
		Product Data																
		Installation Instructions																
		Operation and Maintenance Data																

SECTION 013550 - ASBESTOS PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Procedure to be taken if Asbestos Containing Materials (ACM) identified on the drawings may be disturbed in the course of construction operations.

B. Procedure to be taken if material suspected of being ACM is encountered in the course of construction operations.

C. Procedure to be taken if work is required above ceilings where ACM is known or suspected to be present.

1.2 REFERENCES

A. 29 CFR 1910.1001 - OSHA Asbestos Standard for General Industry

B. 29 CFR 1926.1101 - OSHA Asbestos Standard for the Construction Industry

C. 40 CFR 61 Subpart M - NESHAP

D. 49 CFR 171, 172 & 173 - Department of Transportation (DOT)

1.3 RELATED SECTIONS

A. Section 010650 ENVIRONMENTAL COMPLIANCE; Procedures for removal and disposal of ACM.

1.4 DEFINITIONS

A. Air Monitoring: The process of measuring the fiber content in a specific volume of air in a stated period of time.

B. Asbestos: Chrysotile, amosite, crocidolite, tremolite, anthophyllite and actinolite.

C. ACM: Asbestos Containing Material(s)

D. OMEH: Occupational Medicine and Environmental Health mission service contractor at MSFC.

E. Friable: Capable of being crumpled or reduced to powder by hand pressure.

F. ADEM: Alabama Department of Environmental Management

G. EPA: The Environmental Protection Agency

H. NESHAP: National Emission Standards for Hazardous Air Pollutants

I. OSHA: The Occupational Safety and Health Administration

J. Personal air monitoring: The process of monitoring the fiber content of air in the breathing zone of a worker performing asbestos related work.

1.5 SUBMITTALS

A. Submit the following for all work involving asbestos abatement whether listed on the Schedule of Submittals or not:

B. TRAINING DOCUMENTATION: Submit evidence that all employees exposed to asbestos in excess of the permissible exposure limit have been trained in accordance with the requirements of 29 CFR 1926.1101 and have obtained EPA accreditation in accordance with their duties. Contractor/Supervisor shall obtain Contractor/Supervisor accreditation and workers shall obtain worker accreditation.

C. MEDICAL EXAMINATIONS: List of medical examinations. Also submit a list of all employees that have received medical examinations as required by OSHA regulations (see 1010.134(b) (10) and 1926.1101). This list shall be updated if new employees are hired after work begins. Do not submit medical records.

D. CONTRACTOR LICENSES/CERTIFICATIONS: If asbestos abatement is to be performed as part of this project the contractor shall be licensed in the State of Alabama for the performance of asbestos abatement work.

E. ASBESTOS REMOVAL PLAN: If asbestos work is a part of this contract, submit detailed plan within 10 days after receipt of Notice of Award detailing the Contractor proposed asbestos removal plan. The plan shall include location of asbestos control areas, location and layout of worker decontamination unit, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and encapsulant to be used. The plan shall be approved by the Contracting Officer prior to the start of any asbestos work.

F. PERMITS: Submit proof satisfactory to the Contracting Officer that all required permits, site location and arrangements for transport and disposal of asbestos-containing or contaminated waste materials and supplies have been obtained.

1.6 ADEM NOTIFICATION

A. The Contractor shall notify the following office in writing 10 days prior to beginning any asbestos removal operations; Alabama Department of Environmental Management (ADEM).

B. The Contractor shall supply the Alabama Department of Environmental Management (ADEM) with the following information:

C. Name and address of Contractor.

D. Address and description of the building, including size, age, prior use of the building, and square footage of asbestos-containing material to be removed.

E. Scheduled starting and completion dates for removal.

F. Name and address of landfill where the asbestos waste will be deposited.

G. Copy of a completed EPA Notification of Demolition and Renovation Form.

1.7 QUALITY ASSURANCE

A. Contractors performing work in areas containing ACM shall be qualified and accredited in accordance with OSHA, EPA, ADEM and other governing regulations.

B. Perform all work in accordance with OSHA, EPA, NESHAP, ADEM and other governing regulations.

C. Provide evidence acceptable to the COTR that workers in areas containing ACM or suspect ACM have been properly fitted with respirators and have been properly trained in accordance with 40 CFR part 61 (NESHAP) and other governing regulations. Provide evidence acceptable to the COTR that workers in areas containing ACM or suspect ACM have been properly fitted with respirators and have been properly trained and accredited in accordance with OSHA, EPA and other governing regulations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 MATERIALS IDENTIFIED AS ACM

A. If ACM is identified on the drawings as a product in a known location and the ACM must be removed to accomplish the contract, the removal and disposal shall be a part of this contract unless otherwise specifically stated in the contract documents. Examples are: 1) Asbestos containing pipe insulation where the contract requires removal or reworking of the pipe; 2) Asbestos containing siding or roof deck which must be removed or penetrated as part of the contract.

B. If ACM is identified on the drawings as a product in the vicinity of construction operations and which may accidentally be disturbed during construction, the contractor shall provide protective measures approved by the COTR to prevent its disturbance. Example: Asbestos containing pipe insulation on pipes which are not to be removed or reworked as part of this contract.

C. If friable ACM is identified on the drawings as being present above ceilings, proper procedures (specified herein) shall be used before removal of any portion of the ceiling. Example: Sprayed ACM insulation or fireproofing on structure above a ceiling.

3.2 MATERIAL SUSPECTED OF BEING ACM

A. If an unidentified material is suspected of being ACM:

1. Do not disturb the suspect material.
2. Notify the COTR at once and await instructions. The COTR will arrange for sampling and testing by the OMEH and will provide instructions concerning barricades and warning signs, etc.

3.3 WORK ABOVE CEILINGS

A. If the contract requires any work above a ceiling or removal of a ceiling where ACM is known to be or suspected to be present, the following procedures shall be followed:

1. Notify the COTR of impending operations as soon as practicable (but at least one week) before operations are to begin including a complete schedule for the work.
2. The COTR will arrange for HVAC and other utility outages and other coordination with the Government.
3. Separate the work area from occupied areas by installing "asbestos" warning barricade tape and posting "asbestos" warning signs at entrances to the work area.
4. Wear proper respiratory protection and protective clothing at all times while working in areas where asbestos may be disturbed.
5. Seal the work area as required by OSHA, NESHAP, EPA and other requirements. Seals shall remain until area is cleared and approved by the COTR.
6. Place 6 mil. polyethylene over furniture and floor to collect debris that may fall from above the ceiling. Upon completion of each activity, remove the polyethylene and dispose of it as controlled waste. Ensure that no debris or dust will remain within the room. Remove dust and debris that may fall on furniture or floors using a vacuum equipped with a HEPA filter and properly dispose of the dust as controlled waste. No sweeping or dusting will be allowed. Use wet methods only.
7. COTR will arrange for the Government air monitoring, clearance testing and return of HVAC and other utilities to normal operation, if required. The Contractor shall be responsible for personal air monitoring in accordance with OSHA requirements. The Government will determine if area air monitoring and clearance testing is required for the particular project and if so, will provide this monitoring at no cost to the Contractor.

END OF SECTION 013550

SECTION 01 40 00 — CONTRACTOR QUALITY ASSURANCE/QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This specification sets forth quality assurance/quality control requirements for the provision of materials, equipment, systems, inspections, tests, services, and construction of facilities and site improvements. The quality of work-in-progress and finished work is the responsibility of Contractor line management. These requirements provide for an effective system to ensure that contractual quality requirements and technical criteria are satisfactorily met.

1.2 RELATION TO OTHER CONTRACT DOCUMENTS

A. The requirements of this specification shall be fully complied with in close concert with the detail requirements of the technical specifications and all other contract documents. Overlapping and interfacing contractual requirements shall not result in duplication of Contractor efforts. The quality program shall effectively complement and support functions required by the technical specifications and other contract documents.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 013300, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

A. Preconstruction Submittals: The Contractor shall submit a detailed written statement describing procedures that will be implemented to achieve quality on the project according to the paragraph entitled, "Contractor's Quality Assurance/Quality Control Plan." The plan shall be submitted and approved by the Government prior to Notice to Proceed and describe how the quality requirements of the specifications will be met and address each of the following:

1. Delegation of Contractor's authorized representative responsible for quality assurance/control of contract work.
2. The Contractor's quality assurance/control plan and procedure for accomplishing and reviewing construction methods and controls, fabrication controls, certifications, documentation of quality control operations, inspections, and test records including those required for suppliers and subcontractors. Describe methods to be effected during the procurement cycle (order to deliver) for the selection of construction materials, suppliers, subcontractors, on-site and off-site fabrication and assembly of Contractor- furnished materials and equipment, work procedures, workmanship, and testing to ensure full compliance with plans, specifications, codes, regulatory requirements, and other contract documents.
3. The Contractor's program shall provide for a functional system to document that quality provisions of contract schedules, specifications, and drawings have been performed.
4. Training, certification(s), and re-certification(s) of personnel as required by the specifications.
5. Certification of materials, processes, or equipment as required by the specifications.

6. Qualification of procedures as required by the specifications.
7. Nondestructive testing requirements as required by the specifications.
8. Identification of independent certifying and testing laboratories to be used.

B. Records: Records shall include all quality control data; factory test plans/results, manufacturer's certifications, receiving inspections, deficiency correction reports; construction deficiency reports (CDR); training/certifications; letter of authority or delegation; and routine technical test plans/results, i.e., hydrostatic, electrical continuity, grounding, welding, line cleaning, etc. Quality records shall be available for examination upon request by the designated Government representatives. Quality control records shall be maintained in a central on-site location. Maintenance of quality control records shall not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification. All quality records shall be turned over to the Government's designated representatives as a file of record at contract completion.

1.4 QUALITY ASSURANCE

A. Qualifications: When approval or certification of special processes, operating personnel, and special equipment or procedures is required by the specifications, the Contractor shall obtain necessary approvals or certifications prior to starting the work.

B. Management and Organization: Contractor shall ensure effective execution of quality assurance/quality control functions and provide competent personnel with experience in quality assurance/quality control functions to provide supervision, inspection, and testing. Contractor shall be responsible for each of his suppliers and subcontractors. Contractor shall provide quality assurance oversight of suppliers and subcontractors and ensure that each provides effective quality control in the execution of their work. The program shall encompass management and supervisory actions that affect quality of all work-in-progress and finished construction work. The individual designated to direct the program shall report to the Contractor's management and shall have the necessary authority to discharge his responsibilities.

C. Identification and Data Retrieval: The Contractor shall have an identification and data retrieval system. Records, drawings, submittals, and equipment shall be identified to reference the following:

1. Contract Number
2. Contract Specification Number
3. Contract Drawing Number
4. Submittal Document Number
5. Contract Change Number
6. Contractor's Drawing Number System

D. Procurement: The Contractor shall be responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality requirements. The Contractor shall ensure that his purchase documents include:

1. The basic quality requirements, standards, drawings, and specifications called out in the contract specifications.
2. Inspection and Test Characteristics.

3. Inspection and Test Records.
4. Operational and Maintenance (O&M) manuals, Instructions, Certifications of Compliance, and such other data as may be required by the specification.
5. Preservation, packaging, shipping directions.

E. When Government source inspection is required on a Contractor's purchase, the purchase document shall include the following statement: “All work on this order is subject to inspection and testing by the Government at any time and place. The Contracting Officer shall be notified immediately upon receipt of this order. The Contracting Officer shall be notified 72 hours in advance of the time articles or processes are ready for inspection or test."

F. Procurements that do not require Government source inspection shall include the following statement: "The Government reserves the right to inspect any or all of the materials included on this order at the Contractor's plant."

G. Required Government source inspections will be determined by the Contracting Officer. Government source inspections shall not replace Contractor inspections or relieve the Contractor of his responsibility for ensuring quality procurements and records verifying quality control activities.

H. Receiving Inspection System: Contractor shall maintain a receiving inspection system that ensures procured materials and equipment are inspected and tested as required by specifications, drawings, and approved submittal documents. Shipping/receiving inspection records will accompany each procurement delivery to the construction site. Maintain records of receiving inspections at the construction site by the Contractor. Records shall show defects, discrepancies, dispositions, and waivers, including evidence of Government source inspection.

I. Nonconforming Articles and Material Control: The Contractor shall control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations.

1. Contractor shall prepare a construction deficiency report for each instance comprising:
   a. A unique and traceable number.
   b. Identification of the nonconforming article or material.
   c. A description of the nonconformance and the applicable requirement.
   d. Cause or reason for the nonconformance.
   e. Remedial actions taken or recommended.
   f. Disposition of the nonconforming article or material.
2. The Contractor shall identify, mark, and segregate each nonconforming article for removal from the work area to prevent inadvertent use.
3. The Contractor shall monitor and correct deficient operations.

J. Fabrication, Process, and Work Control: The Contractor's procedures and controls shall be derived from stated requirements in contract specifications and drawings. The Contractor shall establish in-process inspections and ensure compliance with quality requirements that are not readily detectable or measurable by inspection and test of finished elements. Special processes may include, but are not limited to, concrete placement, piping system cleaning, plating, anodizing, nondestructive testing, welding, and soldering.

K. Drawings and Change Control: Drawing-control system shall be maintained to provide revised drawings and change distribution and removal of obsolete drawings from work areas. Changes

involving interface with other work areas, or affecting articles or materials controlled by others shall be controlled by the Contractor. This system shall be integrated with the document requirements of the contract. Drawing changes shall be clearly specified. Accomplished changes shall be clearly identified and associated drawings shall be revised. Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

L. Quality Inspections: Government Inspections: Work performed under the general direction of the Contracting Officer will be subject to inspection by authorized representatives. No representative is permitted to change specifications or drawings without written authorization of the Contracting Officer. Government in-process and end-item inspections may, at the Government's discretion, be performed on site and/or at the Contractor's or subcontractor's facility by Government representatives. Government shall be notified with sufficient advance notice of Contractor work plans which will cover up or make inaccessible previously installed work which may require Government inspection, i.e., backfilling or encasing of any underground utility, concrete placement, etc. Failure to provide such notification may require the work be uncovered to inspect the work. Uncovering and restoration of the work shall be at the Contractor's expense. The Contractor's quality assurance/control program is subject to continuous evaluation, review, and verification by the Contracting Officer. The Contractor will be notified in writing of any noncompliance area and will be given 5 days to correct identified deficiencies.

M. Contractor's Quality Inspections: Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections and tests. Contractor shall ensure that nonconforming products are discovered, documented, and controlled. Procedures eliminating future deficiencies shall be implemented. Contractor's quality assurance system shall include the following:

1. Single Contractor's representative responsible for on-site/off-site communication and operation of the inspection program.
2. Purchasing control system documenting project procurement to drawings, specifications, and approved submittals.
3. Receiving inspection system documenting inspections for each procurement verifying material and equipment is compliant with plans and specifications.
4. Documentation for handling and disposing of nonconforming components and materials.
5. Inspection records as required for each specific section of the specification and drawings.
6. Identification of test(s) to be performed, test procedures, test plans/reports, records, and independent organizations used.
7. Documenting and maintaining certification or re-certification of procedures, personnel, and equipment.
8. Management of Government-furnished equipment, components, and materials.
9. Calibration of gages, tools, measuring instruments, and independent laboratories used and all associated documentation.

N. The Contractor shall establish his own system of scheduled or random sample inspections and audits to ensure objectives are met.

O. Manufacturer's Field Services: Responsibility for Inspection and Testing: Contractor is responsible for the performance of inspections and tests. Each shall be recorded. The Contractor shall utilize independent inspection and testing laboratories or services that are

acceptable to the Government. Tests of construction materials shall be accomplished by the Contractor utilizing the services of an acceptable independent testing laboratory.

P. Inspection and Test Records: The Contractor shall provide on-site records of each inspection and test performed throughout the life of the contract. Records shall include, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, test plans/reports, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Q. Records of in-process inspections and controls away from the job site may be used as evidence of quality of materials/work and, at the discretion of the Government, may reduce further inspection or testing after delivery to the job site.

R. The Contractor shall ensure each record is identified and traceable to specific requirements in the specifications and drawings.

1.5 HANDLING AND STORAGE

A. The Contractor shall provide controls and procedures which meet requirements of each section of the specifications. The Contractor shall include documentation with each shipment. The data shall consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

1.6 SEQUENCING AND SCHEDULING

A. Contractor shall notify the Government a minimum of 48 hours prior to scheduled inspections and tests. Contractor shall provide 24-hour notice to the Government of the date when the contract work will begin at the site. When Contractor suspends work for 5 days or longer prior to completion, he shall notify the Contracting Officer. Work shall not suspend nor resume without notification of the Contracting Officer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the Contracting Officer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Contracting Officer for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

ADAAG	Americans with Disabilities Act (ADA)	
		(800) 872-2253
	Accessibility Guidelines for Buildings and www.access-board.gov	(202) 272-5434
CFR	Code of Federal Regulations www.access.gpo.gov/nara/cfr	(888) 293-6498 (202) 512-1530
CRD	Handbook for Concrete and Cement Available from Army Corps of Engineers	(601) 634-2355

E. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone

numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DOD	www.wes.army.mil	
	Department of Defense Specifications and Standards Available from Defense Automated Printing Service //astimage.daps.dla.mil/online	(215) 697-6257
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Defense Automated Printing Service //astimage.daps.dla.mil/online	(215) 697-6257
	Available from General Services Administration www.fss.gsa.gov/pub/fed-	(202) 619-8925
	Available from National Institute of Building Sciences www.nibs.org	(202) 289-7800
FTMS	Federal Test Method Standard (See FS)	
MILSPEC	Military Specification and Standards Available from Defense Automated Printing Service //astimage.daps.dla.mil/online	(215) 697-6257
NSS	NASA Safety Standards www.hq.nasa.gov/office/codeq/codeg/doctree/1740-9.pdf	
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-5434

1.2 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(202) 862-5100
AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AAN	American Association of Nurserymen (See ANLA)	
AASHTO	American Association of State Highway and Transportation Officials www.aashto.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists (The) www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.abma-dc.org	(202) 367-1155
ACI	American Concrete Institute/ACI International www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
ADC	Air Diffusion Council www.flexibleduct.or	(312) 201-0101
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AFPA	American Forest & Paper Association (See AF&PA)	
AF&PA	American Forest & Paper Association	(800) 878-8878
	www.afandpa.org	(202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AGMA	American Gear Manufacturer's Association www.agma.org	(703) 684-0211

AHA	American Hardboard Association www.ahardbd.org	(847) 934-8800
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AI	Asphalt Institute www.asphaltinstitute.or	(859) 288-4960
AIA	American Institute of Architects (The) www.e-architect.com	(202) 626-7300
AISC	American Institute of Steel Construction	(800) 644-2400
	www.aisc.org	(312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
ALA	American Laminators Association (See LMA)	
ALCA	Associated Landscape Contractors of America www.alca.org	(800) 395-2522 (703) 736-9666
ALSC	American Lumber Standard Committee	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANLA	American Nursery & Landscape Association (Formerly: AAN - American Association of Nurserymen) www.anla.org	(202) 789-2900
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts www.aosaseed.com	(402) 476-3852
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(941) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute www.ari.org	(703) 524-8800

ASCA	Architectural Spray Coaters Association www.ascassoc.com	(609) 848-6120
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	American Society for Testing and Materials www.astm.org	(610) 832-9585
AWCI	AWCI International (Association of the Wall and Ceiling Industries International) www.awci.org	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (See WCMA)	
AWI	Architectural Woodwork Institute www.awinet.org	(800) 449-8811 (703) 733-0600
AWPA	American Wood-Preservers' Association www.awpa.com	(817) 326-6300
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.bia.org	(703) 620-0010
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) www.bifma.com	(616) 285-3963
CCC	Carpet Cushion Council www.carpetcushion.org	(203) 637-1312

CCFSS	Center for Cold-Formed Steel Structures www.umr.edu/~ccfss	(573) 341-4471
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association www.canelect.ca	(613) 230-9263
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CGA	Compressed Gas Association www.cganet.com	(703) 412-0900
CGSB	Canadian General Standards Board www.pwgsc.gc.ca/cgsb	(819) 956-0425
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CMAA	Crane Manufacturer's Association of America, Inc. www.mhia.org	(704) 676-1190
CPA	Composite Panel Association (Formerly: National Particleboard Association) www.pbmdf.com	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRI	Carpet & Rug Institute (The) www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(800) 463-6727 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700

CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
EIA/TIA	Electronic Industries Alliance/Telecommunications Industry Association www.eia.org	(703) 907-7500
EIMA	EIFS Industry Members Association www.eifsfacts.com	(800) 294-3462 (770) 968-7945
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
FCI	Fluid Controls Institute www.fluidcontrolsinstitute.org	(216) 241-7333
FGMA	Flat Glass Marketing Association (See GANA)	
FM	Factory Mutual System (See FMG)	
FMG	FM Global (Formerly: FM - Factory Mutual System) www.fmglobal.com	(401) 275-3000
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANA	Glass Association of North America (Formerly: FGMA - Flat Glass Marketing Association) www.glasswebsite.com/gana	(785) 271-0208
GRI	Geosynthetic Research Institute www.drexel.edu/gri	(215) 895-2343
GTA	Glass Tempering Division of Glass Association of North America (See GANA)	
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900

HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAS	International Approval Services (See CSA International)	
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(508) 394-4424
ICRI	International Concrete Repair Institute (The) www.icri.org	(703) 450-0116
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IESNA	Illuminating Engineering Society of North America www.iesna.org	(212) 248-5000
IGCC	Insulating Glass Certification Council www.igcc.org	(315) 646-2234
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
IRI	Industrial Risk Insurers	(800) 243?8308 (860) 520?7300
ITS	Intertek Testing Services www.itsglobal.com	(800) 345-3851 (607) 753-6711
IWS	Insect Screening Weavers Association (Now defunct)	
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LGSI	Light Gage Structural Institute www.loseke.com	(972) 370-0967
LMA	Laminating Materials Association (Formerly: ALA - American Laminators Association) www.lma.org	(201) 664-2700
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864 (847) 577-7200
LSGA	Laminated Safety Glass Association (See GANA)	
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333

MCA	Metal Construction Association www.metalconstruction.org	(312) 201-0193
MFMA	Maple Flooring Manufacturers Association www.maplefloor.org	(847) 480-9138
MFMA	Metal Framing Manufacturers Association	(312) 644-6610
MGPHO	Medical Gas Professional Healthcare Organization, Inc. www.mgpho.org	(877) 238-5157 (913) 681-6548
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-	(614) 228-6194
ML/SFA	Metal Lath/Steel Framing Association	
MSS	(See SSMA)	(703) 281-6613
	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(312) 332-0405
NAAMM	North American Association of Mirror Manufacturers (See GANA)	
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NAIMA	North American Insulation Manufacturers Association (The) www.naima.org	(703) 684-0084
NAMI	National Accreditation and Management Institute, Inc.	(304) 258-5100
NAPM	National Association of Photographic Manufacturers (See PIMA)	
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(414) 248-9094
NCTA	National Cable Television Association www.ncta.com	(202) 775-3669

NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers' Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(303) 697-8441
NFPA	National Fire Protection Association www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council	(301) 589-6372
NGA	www.nfrc.org National Glass Association www.glass.org	(703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933?0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association www.nofma.org	(901) 526-5016
NPA	National Particleboard Association (See CPA)	
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSA	National Stone Association www.aggregates.org	(800) 342-1415 (703) 525-8788
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NTMA	National Terrazzo and Mosaic Association, Inc. www.ntma.com	(800) 323-9736 (703) 779-1022
NWWDA	National Wood Window and Door Association (See WDMA)	

PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting and Decorating Contractors of America www.pdca.com	(800) 332-7322 (703) 359-0826
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (508) 230-3516
PGI	PVC Geomembrane Institute //pgi-tp.ce.uiuc.edu	(217) 333-3929
PIMA	Photographic & Imaging Manufacturers Association (Formerly: NAPM - National Association of Photographic Manufacturers) www.pima.net	(914) 698-7603
RCSC	Research Council on Structural Connections www.boltcouncil.org	(800) 644-2400 (312) 670-2400
RFCI	Resilient Floor Covering Institute (Contact by mail only)	
RIS	Redwood Inspection Service www.calredwood.org	(888) 225-7339 (415) 382-0662
RMA	Rubber Manufacturers Association www.rma.org	(800) 220-7620 (202) 682-4800
SAE	SAE International	(724) 776-4841
SDI	Steel Deck Institute www.sdi.org	(847) 462-1930
SDI	Steel Door Institute	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabfurn.com	(843) 689-6878
SGCC	Safety Glazing Certification Council www.sgcc.org	(315) 646-2234
SIGMA	Sealed Insulating Glass Manufacturers Association www.sigmaonline.org/sigma	(312) 644-6610
SJI	Steel Joist Institute www.steeljoist.org	(843) 626-1995
SMA	Screen Manufacturers Association	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980

SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) www.sprayfoam.org	(800) 523-6154
SPI	The Society of the Plastics Industry www.plasticsindustry.org	(202) 974-5200
SPIB	Southern Pine Inspection Bureau (The) www.spib.org	(850) 434-2611
SPI/SPFD	The Society of the Plastics Industry Spray Polyurethane Foam Division (See SPFA)	
SPRI	SPRI (Single Ply Roofing Institute) www.spri.org Industries	(781) 444-0242
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSMA	Steel Stud Manufacturers Association (Formerly: ML/SFA - Metal Lath/Steel Framing Association) www.ssma.com	(312) 456-5590
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(800) 837-8303 (412) 281-2331
STI	Steel Tank Institute www.steeltank.co	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.co	(216) 241-7333
SWRI	Sealant, Waterproofing, and Restoration Institute www.swrionline.org	(816) 472-7974
TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453
TIA/EIA	Telecommunications Industry Association/Electronic Alliance www.tiaonline.or	(703) 907-7700
TPI	Truss Plate Institute	(608) 833-5900
TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 705-9898

UFAC	Upholstered Furniture Action Council www.ufac.org	(336) 885-5065
UL	Underwriters Laboratories Inc. www.ul.com	(800) 704-4050 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USITT	United States Institute for Theatre Technology, Inc. www.culturenet.ca/usitt	(800) 938-7488 (315) 463-6463
USP	U.S. Pharmacopeia www.usp.org	(800) 822-8772 (301) 881-0666
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (Formerly: AWCMA - American Window Covering Manufacturers Association)	(800) 506-4653 (212) 661-4261
WDMA	www.windowcoverings.org	(800) 223-2301
	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association)	(847) 299-5200
WIC	Woodwork Institute of California www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.
Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

BOCA	BOCA International, Inc. www.bocai.org	(708) 799-2300
CABO	Council of American Building Officials (See ICC)	

IAPMO	International Association of Plumbing and Mechanical Officials (The) www.iapmo.org	(909) 595-8449
ICBO	International Conference of Building Officials www.icbo.org	(800) 284-4406 (562) 699-0541
ICC	International Code Council (Formerly: CABO - Council of American Building Officials) www.intlcode.org	(703) 931-4533
SBCCI	Southern Building Code Congress International, Inc. www.sbcci.org	(205) 591-1853

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers www.usace.arm y.mil	
CPSC	Consumer Product Safety Commission 638-2772 www.cpsc.gov (301) 504-0990	(800)
DOC	Department of Commerce 482-2000 www.doc.gov	(202)
EPA	Environmental Protection Agency 260-2090 www.epa.gov	(202)
FAA	Federal Aviation Administration www.faa.gov	(202) 366-4000
FCC	Federal Communications Commission www.fcc.gov	(202) 418-0190
FDA	Food and Drug Administration www.fda.gov	(888) 463-6332
GSA	General Services Administration www.gsa.gov	(202) 708-5082
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley Laboratory (See LBNL)	

LBNL	Lawrence Berkeley National Laboratory www.lbl.gov	(510) 486-5605
NCHRP	National Cooperative Highway Research Program (See TRB)	
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(202) 693-1999
RUS	Rural Utilities Service (See USDA)	(202) 720-9540
TRB	Transportation Research Board www.nas.edu/trb	(202) 334-2934
USDA	Department of Agriculture www.usda.gov	(202) 720-2791
USPS	Postal Service www.usps.co	(202) 268-2000

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CAPUC	(See CPUC)	(800) 952-5210
CBHF	State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation www.dca.ca.gov/bhfti	(916) 445-1254
CPUC	California Public Utilities Commission www.cpuc.ca.gov	(415) 703-2782
TFS	Texas Forest Service Forest Products Laboratory //txforestservice.tamu.edu	(936) 639-8180

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following administrative and procedural requirements, selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Sections include the following:

1. Division 1 Section "References" for applicable industry standards for products specified.
2. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.
3. Remaining Division Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

A. Products: Items purchased for incorporating into the Work. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents. Named products or manufacturers are not pre-approved by the Government and are provided for information only. Manufacturers or products named as “Basis of Design” identify type, function, dimension, in-service performance, physical properties, appearance, and other characteristics desired by the Government.
2. Comparable or Equal Product: A product or product substitution that is demonstrated through the submittal process, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that are equal or exceed those of named product. .

B. Substitutions: Contractor proposed use of manufacturer’s products, materials, or equipment different from those identified in the Contract Documents. .

C. Product Specification: Product qualities and features related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for evaluating product compliance with project requirements.

1.3 SUBSTITUTIONS:

A. Substitution Requests: A substitution request form must be completed for all products submitted other than the “Basis of Design” products. Complete the form at the end of this section, and attach to each copy of the submittal of the product. Identify product or fabrication

or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
   a. Statement indicating why specified material or product cannot be provided.
   b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Government and separate contractors, that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   e. Samples, where applicable or requested.
   f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
   g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
   h. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
   i. Cost information, including a proposal of change, if any, in the Contract Sum.
   j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, the Contracting Officer will determine which products shall be used.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products to allow for inspection and measurement of quantity or counting of units.
6. Store materials in a manner that will not endanger Project structure.
7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
9. Protect stored products from damage.
10. Product shall be stored and handled in a safe manner and housekeeping conducted daily to the satisfaction of the Contracting Officer.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
4. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

2.2 PRODUCT SUBSTITUTIONS

A. Timing: The Contracting Officer will consider requests for substitution if received within 90 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of the Contracting Officer.

B. Conditions: The Contracting Officer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, the Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers the Government a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities the Government must assume.
2. Requested substitution does not require extensive revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution is compatible with other portions of the Work.
7. Requested substitution has been coordinated with other portions of the Work.
8. Requested substitution provides specified warranty.
9. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

Advancement of Construction Technology

SUBSTITUTION REQUEST
(After the Bidding Phase)

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ Project Number: _____

Re: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 2-5 years old ☐ 5-10 yrs old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

_____

_____

☐ Point-by-point comparative data attached

Reason for not providing specified item: _____

_____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

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

_____

Savings to Government for accepting substitution: _____ ($ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____days.

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

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SUBSTITUTION REQUEST
(Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

Attachments: _____

_____

_____

_____

GOVERNMENT'S REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01330.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01330.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: Date:

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ COTR

_____

_____

_____

_____

_____

_____

_____

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SECTION 017000 — PROJECT MEETINGS

PART 1 - GENERAL

1.1 PRECONSTRUCTION CONFERENCE

A. The Contractor shall attend a preconstruction conference scheduled by the Contracting Officer. Work shall not commence prior to the conference. Subcontractor representatives shall attend.

1.2 PROJECT MEETINGS

A. The Contractor shall attend project meetings scheduled by the Government to discuss safety, the project submittals status, the project construction schedule, and construction issues. The Contractor shall provide a representative from his organization with expertise and knowledge in matters related to the project Schedule. The representative shall have the responsibility of updating and coordinating the Schedule with actual job conditions. During this meeting, the Contractor shall describe, on an activity-by-activity basis, all proposed revisions and adjustments to the project Schedule required to reflect the current status of the project. The Contracting Officer shall approve activity progress, proposed revisions and adjustments as appropriate. Only Contracting Officer approved revisions and adjustments shall be incorporated into the schedule. The representative shall also present current information on the status of purchase orders, shop drawings, off-site fabrication, material deliveries, Subcontractor activities, anticipated needs for any Government-Furnished Equipment (GFE), and any problem which may impact the contract performance period. Subcontractor representatives shall attend as appropriate and as requested.

1.3 PREPARATORY MEETINGS

A. The contractor shall conduct preparatory meetings prior to the start of all new elements of work. The meeting shall include as a minimum representatives of the contractor performing the work, the GC site superintendent or foreman, and Government Inspector. Two days advance notice of preparatory meetings shall be given.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017000

SECTION 017310 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:

1. Division 7 Section "Through-Penetration Firestop Systems" for patching fire-rated construction.

2. All Division Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work. Refer to mechanical and electrical Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations

1.2 DEFINITIONS

A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.3 SUBMITTALS

A. Cutting and Patching Proposal: Unless otherwise determined by the COTR, the contractor shall submit, at least 10 days before the time of cutting and patching, a proposal describing procedures that will be performed, and request approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
6. Structural Elements: Where cutting and patching involve modification of any structural element, submit details showing the proposed mofication and integration with original structure.

1.4 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-protection systems.
4. Control systems.
5. Communication systems.
6. Conveying systems.
7. Electrical wiring systems.

C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Equipment supports.
5. Piping, ductwork, vessels, and equipment.
6. Noise- and vibration-control elements and systems.
7.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1. Retain recognized, experienced, and specialized firm to cut and patch exposed Work listed below.

    a. Processed concrete finishes.
    b. Stonework and stone masonry.
    c. Ornamental metal.
    d. Preformed metal panels.
    e. Roofing.
    f. Firestopping.
    g. Window wall system.
    h. Fluid-applied flooring.
    i. Aggregate wall coating.
    j. Wall covering.
    k. HVAC enclosures, cabinets, or covers.

E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 WARRANTY

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections of these Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

END OF SECTION 017310

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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 the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 010650 “Environmental Compliance” for MSFC specific waste management procedures

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

G. Total Recovered Material: Waste materials and byproducts that have been recovered or diverted from solid waste, but does not include materials and byproducts generated from, and commonly reused within, an original manufacturing process.

1.4 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:
   a. Asphalt paving.
   b. Concrete.
   c. Concrete reinforcing steel.
   d. Structural and miscellaneous steel.
   e. Acoustical tile and panels.
   f. Piping.
   g. Valves.
   h. Mechanical equipment.
   i. Refrigerants.
   j. Electrical conduit.
   k. Copper wiring.
   l. Lighting fixtures.
   m. Lamps.
   n. Ballasts.
   o. Electrical devices.
   p. Switchgear and panelboards.
   q. Transformers.

2. Construction Waste:
   a. Masonry and CMU.
   b. Lumber.
   c. Wood sheet materials.
   d. Wood trim.
   e. Metals.
   f. Roofing.
   g. Insulation.
   h. Carpet and pad.
   i. Gypsum board.
   j. Piping.
   k. Electrical conduit.
   l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
      1) Paper.
      2) Cardboard.
      3) Boxes.
      4) Plastic sheet and film.
      5) Polystyrene packaging.
      6) Wood crates.
      7) Plastic pails.

1.5 SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste.

B. Waste Reduction Final Report: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste.

C. Landfill and Incinerator Disposal Records or Recycling and Processing Facility Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities or of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 WASTE REDUCTION PROGRESS REPORTS:

A. Concurrent with each Application for Payment, submit report. Use Form CWM- 1 for construction waste and Form CWM-2 for demolition waste. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

PART 3 - EXECUTION

3.1 IMPLEMENTATION

A. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, and reused
2. Comply with Division 01 Sections for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION ITEMS

A. Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Turn over to the COTR or install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Lighting Fixtures: Separate lamps by type and protect from breakage.

C. Electrical Devices: Separate switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. NOTE: The policies, procedures and restrictions of the landfill and recycling organizations above are not governed by NASA and are subject to change. All contractors should contact these agencies directly to familiarize themselves with the policies, procedures and restrictions prior to bidding and prepare their bids accordingly.

B. General: Recycle paper and beverage containers used by on-site workers.

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

D. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

E. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.

1. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
2. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
3. Store components off the ground and protect from the weather.

4. Remove recyclable waste from Government's property.

3.4 RECYCLING DEMOLITION WASTE

A. Metals: Separate metals by type.

1. Structural Steel and Siding: Stack members according to size, type of member, and length.
2. Piping: Separate and store by type. Separate supports, hangers, valves, sprinklers, and other components by type.
3. Conduit: Separate and store by type.

B. Concrete and Masonry: Segregate block and concrete.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a manner acceptable to the Government.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials and dispose at the Redstone Arsenal Landfill, if permissible, or legally dispose off the Government's property. Review Division 01 Section "Environmental Compliance" for further disposal information.

3.7 REDSTONE ARSENAL LANDFILL (RSAL) (Phone # 256-876-4199)

A. The following restrictions concerning use of the Government's Redstone Arsenal Landfill (RSAL) are provided for general use as an example of some of the policies and restrictions that historically have been associated with the RSAL. They are not to be considered complete or necessarily correct. The policies, procedures, and restrictions of the landfill and recycling organizations above are not governed by NASA and are subject to change. All contractors should contact these agencies directly to familiarize themselves with the policies, procedures, and restrictions prior to bidding and prepare their bids accordingly.

1. No garbage shall be mixed in with the construction rubble for disposal at the Redstone Arsenal Landfill (RSAL).
2. No liquids of any kind shall be disposed of at the RSA
3. No ammunition or explosive type material (including training devices) shall be disposed of at the RSAL.
4. No batteries shall be disposed of at the RSAL.
5. No hazardous wastes shall be disposed of at the RSAL, except asbestos as noted herein.
6. Large pieces of heavy metal, copper, metal shavings, etc. shall not be disposed of at the RSAL.
7. Asbestos shall be segregated and disposed of in a designated area of the RSAL.
8. Cans of 1 gallon or larger that contain paint, solvent, or any other liquid shall not be disposed of in the RSAL.
9. Empty drums in good condition from 5-gallon containers and up shall not be disposed of in the RSAL.
10. Empty drums in poor condition shall be flattened prior to delivery for disposal to the RSAL.
11. There will be no loitering or scrounging at the RSAL.

B. For all demolition and construction waste to be disposed of at the RSAL, the Contractor shall submit documentation ensuring compliance with ADEM Permit No. 45-3 issued for the RSAL. The MSFC Environmental Engineering and Occupational Health Office (AS10) will provide to the Contractor the Certification Number to be used for the project. The Contractor shall complete all applicable portions of the form's "Material Certification" page except as described below. Upon completion, the Facility Management Office Construction Support Contractor shall submit the "Material Certification" to AS10. MSFC AS10 will complete the "Waste Certification" and "Material Certification" sections of the Form 2435-R and forward it to the RSAL. The Contractor shall complete a Form 4235-R, "Delivery Ticket" for each load using the specific project's Certification Number.

C. The Government will refuse any material or not allow dumping of any material at the site if it does not meet the above requirements. If this occurs, the Contractor is responsible to dispose of the waste material offsite at approved landfills at his own expense.

3.8 ATTACHMENTS

A. Form CWM-1 for construction waste

B. Form CWM-2 for demolition waste.

END OF SECTION 01 74 19

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes, but is not limited to, administrative and procedural requirements for contract closeout.

B. Related Sections include the following:

1. Specification Section 017820 "Operation and Maintenance Data" for operation and maintenance manual requirements.
2. Division 1 Section "Demonstration and Training" for requirements for instruction of the Government's personnel.
3. Refer to applicable sections for specific closeout and special cleaning requirements for products of those Sections.

1.2 FINAL INSPECTION

A. Before requesting final inspection, complete the following:

1. All salient parts of the work are substantially complete.
2. All systems and subsystems are substantially complete.
3. Startup testing of systems is complete.
4. Test and Balance is complete and final report is approved.
5. The commissioning is complete to the following level:
   a. Completed and signed start-up and prefunctional checklist documentation.
   b. Requested trend log data provided.
   c. Building UCS system is functioning as designed.
   d. Completion of all functional testing.
   e. Required training of Owner personnel completed.
   f. All identified deficiencies have been corrected or are approved by the Owner to be excepted from this milestone
6. Submission and approval of Operation and Maintenance Manuals.

B. The Owner's Project Manager will determine the date of Functional Completion after reviewing the Commissioning Agent's recommendation for Functional Completion

C. Instruct Government's personnel in operation, adjustment, and maintenance of products, equipment, and systems. The Owner's Project Manager will determine the date of Functional Completion after reviewing the Commissioning Agent's recommendation for Functional Completion

D. Inspection: Request a final inspection for acceptance. On receipt of request, the Government will either schedule a day for the inspection or reject the Contractor's request for due cause.

Requests for “partial” final inspections will only be considered when multiple and functionally separate buildings are involved or when the project is phased or when systems or occupancies are required by the Government. The Government reserves the right to reject all “partial” requests.

E. After final inspection, the Government shall issue a punch list to be completed by the Contractor.

1.3 PROJECT CLOSEOUT SUBMITTALS

A. As-built Drawings: Submit the redlined as-built drawing set maintained by the Contractor and verified by the Government as defined in Part 2.

B. Operation And Maintenance Data Manuals: Submit O&M manual in accordance with Specification Section 017820

C. Warranties: Organize warranty documents into an orderly sequence.

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (115-by-280-mm) paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Provide additional copies of each warranty and include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 AS-BUILT DRAWINGS

A. As-built Drawings: Maintain one set of prints of the Contract Drawings and Shop Drawings at the project site.

1. Preparation: Mark As-built Prints completely and accurately to show the actual installation. The construction contractor shall include on the as-built drawings all variances from that shown on original drawings and all utilities that are field routed in and/or under concrete slabs, walls or masonry walls and/or concealed or buried in the ground. The as-built drawings shall be prepared in reference to the building column lines and include all concealed utilities, depths, and locations from building column lines.
   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Accurately record information in an understandable drawing technique.
   c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.

d. For DCR's, RFI's, CDR's, and Change Items, cloud the area on the drawing affected by the change, note the changing document number, and attach the approved changing document to the affected drawing.

2. Content: Types of items requiring marking include, but are not limited to, the following:
   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Depths of foundations below first floor.
   d. Locations and depths of underground utilities. Prior to utilities burial or concrete placement, record horizontal location of utilities with respect to distances from column lines or other permanent features and record depth of underground utilities with respect to grade level or top of concrete slab.
   e. Revisions to identified routing of piping and conduits.
   f. Revisions to electrical circuitry.
   g. Actual equipment locations.
   h. Duct size and routing.
   i. Locations of concealed internal utilities.
   j. Changes made by Change Order.
   k. Changes made following the Contracting Officer's written orders.
   l. Details not on the original Contract Drawings.
   m. Field records for variable and concealed conditions.
   n. Record information on the Work that is shown only schematically.
   o. Note and dimension all underground utilities and structures (including existing) on the drawings.
3. Mark as-built set with red-colored pen.
4. Mark important additional information that was either shown schematically or omitted from original Drawings.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period. Post changes and modifications to Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Provide access to Project Record Documents at the project site during normal working hours.

3.2 PROJECT CLOSEOUT

A. General: The final pay application shall not be accepted by the Government until all contract requirements are met and the following is performed.

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:

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. 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.
f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
g. Sweep concrete floors broom clean in unoccupied spaces.
h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
i. 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.
j. Remove labels that are not permanent.
k. 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.
l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Replace parts subject to unusual operating conditions.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction.
q. 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 fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
r. Leave Project clean and ready for occupancy.

C. Complete all punch list items.

D. Demobilize and remove all temporary utilities.

E. Complete all submittal requirements.

F. All permits shall be closed out, notifications made, and hazardous wastes removed.

G. All DCR's signed and closed out.

H. Turn in excess and salvage materials and spare parts as required.

I. Security: Turn in badges, decals, passes, keys, and all other security items.

J. Final Reports: Contractor accident and safety statistics.

K. Release all liens.

L. All permits shall be closed out, notifications made, and hazardous waste removed.

M. Operation and Maintenance Manuals: Submit operation and maintenance data in accordance with Section 017820.

3.3 PUNCHLIST

A. The Contractor shall complete all punch list items as quickly as possible but within 30 days after final inspection.

END OF SECTION 017700

SECTION 017820 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Operation and Emergency manuals for systems, subsystems, and equipment.
3. Maintenance manuals for the care and maintenance of products, materials, and systems and equipment.

B. Related Sections include the following:

1. Division1 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Division1 Section "Closeout Procedures" for submitting operation and maintenance manuals.
3. Refer to applicable sections for specific operation and maintenance manual requirements for products in those Sections.

1.2 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 SUBMITTALS

A. O & M Manual(s) Submittal: Submit 2 hard copies of each manual in final form at least 30 days before final inspection. In addition to hard copies of each manual, provide CD ROM of operation and maintenance data using PDF format from Adobe Acrobat.

1.4 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include a list of equipment for each system.

C. List of Equipment: List equipment organized alphabetically that is not already listed as a part of a system or subsystem.

D. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with the same designation used in the Contract Documents. If no designation exists, consult with the COTR.

2.2 MANUALS, GENERAL

A. 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.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Date of submittal.
4. Name, address, and telephone number of Contractor.

C. 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.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. 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.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (115-by-280-mm) paper; with

clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets by stating Volume ___ of ___, where the first blank is the subject volume and the second blank is the total number of volumes.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch (115-by-280-mm), 20-lb/sq. ft. (75-g/sq. m) white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION AND EMERGENCY 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.
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.
11. Type of Emergency
12. Emergency instructions
13. Emergency procedures

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification by MAXIMO number with corresponding 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/Emergency operating instructions and procedures.

D. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

E. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

F. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

G. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

H. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUAL

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: Provide separate booklet of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

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 the 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 printed 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 videotape, 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.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

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: Provide separate booklet of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

2.6 COMMISSIONING O & M MANUAL

A. Submit in accordance with Section 019113.

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. Emergency, Operation and Maintenance Manuals: Assemble a complete set of emergency, operation and maintenance data and procedures indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Manuals may be used by emergency personnel and by Owner’s operating personnel for types of emergencies indicated.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

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 by MAXIMO number if applicable. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents by MAXIMO number if applicable. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

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 As-Built Drawings to ensure correct illustration of completed installation.

F. Comply with Division 1 Section "Closeout Procedures" for the schedule for submitting operation and maintenance documentation.

END OF SECTION 017820

SECTION 018200 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for training Government's personnel in the operation and maintenance of systems, subsystems, and equipment.

1.2 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, and instructors' names for each training module. Include learning objective and outline for each training module.

1. At completion of training, submit one complete training manual(s) for the Government's use in CD .pdf format.

B. Qualification Data: For firms and instructors identified in "Quality Assurance" demonstrate their capabilities and experience to conduct training for the system and equipment specified. Include lists of previous training on completed projects with project names and addresses, and other information specified.

C. Demonstration and Training DVD: Submit two copies at end of each training module.

1.3 QUALITY ASSURANCE

A. Trainer Qualifications: A firm or individual experienced in training maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

1.4 COORDINATION

A. Coordinate instruction schedule with the Government's operations. Adjust schedule as required to minimize disrupting the Government's operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the Government.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:

1. Motorized doors, including overhead coiling doors, overhead coiling grilles, and automatic entrance doors.
2. Fire-protection systems, including fire alarm, fire pumps, and fire-extinguishing systems.
3. Intrusion detection systems.
4. Conveying systems, including elevators, wheelchair lifts, escalators, and cranes.
5. Laboratory equipment, including laboratory air, and vacuum equipment and piping.
6. Heat generation, including boilers; feed water equipment, pumps, steam distribution piping, and water distribution piping.
7. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
8. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
9. HVAC instrumentation and controls.
10. Electrical service and distribution, including transformers, switchboards, panel boards, uninterruptible power supplies, and motor controls.
11. Packaged engine generators, including transfer switches.
12. Lighting equipment and controls.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following, if applicable:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.

2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Operations manuals.
   c. Maintenance manuals.
   d. Identification systems.
   e. Warranties.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.

c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.

5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

3.2 INSTRUCTION

A. Trainer: Engage a qualified trainer to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and the Government for number of participants, instruction times, and location.

B. Provide instructors to instruct the Government's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

C. Schedule training with the Government at least fourteen calendar days' advance notice.

D. Demonstration and Training Session: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. For each training module, submit list of participants and length of instruction time.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

E. Cleanup: Collect used and leftover educational materials and give to the Government. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 018200

SECTION 019113 — GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components. Building systems that will be commissioned are specified in Paragraph 1.8. The commissioning process, which the Contractor is responsible to execute, is described in this section. The commissioning process will be directed by a Commissioning Authority whose services will be provided by NASA.

1.2 DESCRIPTION

A. Commissioning. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation left on site is complete.
4. Verify that the Owner's operating personnel are adequately trained.

B. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur:

1. Commissioning during construction begins with a scope meeting conducted by the CA where the commissioning process is reviewed with the commissioning team members.
2. Additional meetings will be required throughout construction, scheduled by the CA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
3. Equipment documentation is submitted and given to the CA during normal submittals.
4. The CA works with the GC in developing startup plans and startup documentation formats, including providing the GC with prefunctional checklists to be completed during the startup process.
5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels. Prefunctional

checklists shall be completed before TAB work starts, and TAB shall be completed before functional verification begins.

6. The GC is responsible for making sure that EC, MC, and CC execute and document the prefunctional checklists and perform startup. The CA documents that the checklists and startup were completed according to the approved plans. This may include the CA witnessing start-up of selected equipment.
7. The CA develops specific equipment and system functional performance verification procedures. The EC, MC, and CC review the procedures.
8. The functional performance verification procedures are executed by the EC, MC, and CC, under the direction of, and documented by the CA.
9. Items of non-compliance in material, installation or setup are corrected at the Contractors' expense and the system retested.
10. The CA reviews the O&M documentation for completeness.
11. Commissioning is completed before Substantial Completion.
12. Deferred testing is conducted, as specified or required.

C. Related Sections

1. 01 32 00 - Project Schedule
2. 01 33 00 - Submittals
3. 01 77 00 - Closeout
4. 23 08 10 - Mechanical Systems Commissioning
5. 23 09 00 HVAC Instrumentation and Controls
6. 23 09 23 Direct Digital Control/Utility Control System
7. 23 05 93 Testing, Adjusting, and Balancing

D. Abbreviations

1. The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Paragraph 1.4.

A/E	Architect and design engineers	GC	General contractor (prime)
BAS	Building Automation System	IOM	Installation, Operation, Maintenance Manual
BoD	Basis of Design document	MC	Mechanical contractor
CA	Commissioning Authority	OPR	Owner's Project Rquirements
		O&M	Operation and Maintenance
CC	Controls contractor	PC	Prefunctional checklist
Cx	Commissioning	PM	Project manager (of the Owner)
Cx Plan	Commissioning Plan document	Subs	Subcontractors to General
EC	Electrical contractor	TAB	Test, Adjust, and Balance contractor
FPV	Functional performance verification		

1.3 RELATED DOCUMENTS

A. OPR and BoD documentation are included by reference for information only.

1.4 DEFINITIONS

A. BoD: a document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

B. Commissioning authority: an independent agent, not otherwise associated with the A/E team members or the Contractor, though he/she may be hired as a subcontractor to them. The CA directs and coordinates the day-to-day commissioning activities.

C. Contractor: the general contractor or authorized representative.

D. Cx Plan: The commissioning plan provides guidance in the execution of the commissioning process. After the initial commissioning scope meeting, the CA will update the plan, which is then considered the "final" plan, though it will continue to evolve and expand as the project progresses. The specifications will take precedence over the Commissioning Plan.

E. Functional Performance Verification (FPV): verification of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional performance verification is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure set point). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. FPVs are performed after prefunctional checklists, startups, and TAB are complete.

F. General Contractor: the prime contractor for this project. Generally refers to all the GC's subcontractors as well. Also referred to as the Contractor, in some contexts.

G. Indirect Indicators: indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.

H. Manual Test: using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

I. Monitoring: the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.

J. Non-Compliance: a condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent). Also: code violations, control sequence conflicts, etc.

K. OPR: A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information

L. Over-written Value: writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50F to 75F to verify economizer operation). See also “Simulated Signal.”

M. Prefunctional Checklist: a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CA to the Subs. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). Prefunctional checklists augment and are combined with the manufacturer’s start-up checklist. Even without a commissioning process, contractors typically perform some, if not many, of the prefunctional checklist items a commissioning authority will recommend. Therefore, the contractors execute the checklists. The commissioning authority requires that the procedures be documented in writing, and will witness much of the prefunctional check listing.

N. Project Manager: the contracting and managing authority for the owner over the design and/or construction of the project.

O. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.

P. Seasonal Performance Tests: FPV that is deferred until the system(s) will experience conditions closer to their design conditions.

Q. Simulated Condition: condition that is created for the purpose of testing the response of a system (e.g., applying a hot air blower to a space sensor to see the response in a VAV box).

R. Simulated Signal: disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

S. Startup: the initial starting or activating of dynamic equipment, including executing prefunctional checklists.

T. Subs: the subcontractors to the GC who provide and install building components and systems.

U. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

V. Test Procedures: the step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CA.

W. Trending: monitoring using the building control system.

X. Vendor: supplier of equipment.

1.5 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of the General Contractor (GC or Contractor), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment, and specialists deemed appropriate by the CA.

B. Members Appointed by Owner:

1. CA: The designated person, company, or entity that plans, schedules, chairs, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.6 COORDINATION

A. Management. The CA is hired by the Owner directly. The CA directs and coordinates the commissioning activities and the reports to the PM. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

B. Scheduling. The CA will work with the GC according to established protocols to schedule the commissioning activities. The CA will provide sufficient notice to the GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process. The CA will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. The Commissioning Plan—Construction Phase provides a format for this schedule. As construction progresses more detailed schedules are developed by the CA. The Commissioning Plan also provides a format for detailed schedules.

1.7 RESPONSIBILITIES

A. The responsibilities of various parties in the commissioning process are as follows:

B. ALL PARTIES’ RESPONSIBILITIES

1. Follow the Commissioning Plan.
2. Attend commissioning scoping meeting and additional meetings, as necessary.

C. OWNER'S RESPONSIBILITIES

1. Provide the OPR documentation to the CA for information and use.
2. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
3. Coordinate activities specified in paragraph below with Architect/Engineer.

4. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
5. Provide final approval for the completion of the commissioning work.

D. GENERAL CONTRACTOR'S RESPONSIBILITIES

1. Work with the CA, to ensure that commissioning activities are being scheduled into the construction schedule.
2. Include the cost of commissioning in the total contract price.
3. In each purchase order or subcontract written, include requirements for commissioning tasks and training.
4. Provide submittals for commissioned systems to CA for CA's review, concurrent to A/E submittal review.
5. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
6. Develop an enhanced start-up and initial systems checkout plan with CA.
7. Coordinate the training of owner personnel. Provide the training plan to the CA at least one month before the training is scheduled to begin.
8. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

E. EACH SUB-CONTRACTOR'S RESPONSIBILITIES

1. Each Sub-Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
   a. Integrate and coordinate commissioning process activities with construction schedule. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
   b. Review and accept prefunctional checklists provided by the CA.
   c. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
   d. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).
   e. The Mechanical Contractor, Controls Contractor, and TAB contractor shall comply with Section 23 08 10 - Mechanical Systems Commissioning.
   f. The Electrical Contractor shall comply with Section 26 08 10 - Electrical Systems Commissioning.

F. CA'S RESPONSIBILITIES

1. The role of the CA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. Perform commissioning process activities including, but not limited to, the following:
   a. Organize and lead the commissioning team.
   b. Provide and revise, as necessary, the Commissioning Plan.
   c. Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation,

clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.

d. Coordinate the commissioning work and ensure that commissioning activities are being scheduled into the construction schedule.
e. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
f. Request and review additional information required to perform commissioning tasks, including IOMs, and contractor start-up and checkout procedures.
g. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
h. Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
i. Write and distribute prefunctional tests and checklists.
j. Develop an enhanced start-up and initial systems checkout plan with GC.
k. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Assist in resolving any discrepancies.
l. Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Notify owner's project manager of any non-compliance issues in results or procedures.
m. Witness all or part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Notify owner's project manager of any non-compliance issues in results or procedures.
n. Approve prefunctional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.
o. Approve systems startup by reviewing start-up reports and by selected site observation.
p. Witness systems, assemblies, equipment, and component startup.
q. Review TAB execution plan.
r. Oversee sufficient functional testing of the control system and approve it to be used for TAB, before TAB is executed.
s. Approve air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
t. Write the functional performance test procedures for equipment and systems.
u. Analyze any functional performance trend logs and monitoring data to verify performance.
v. Coordinate, witness, and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
w. Maintain a Commissioning on-compliance Issues and Resolution log and a separate testing record.
x. Witness performance testing of smoke control systems by others and all other owner contracted tests or tests by manufacturer's personnel over which the CA may not have direct control.
y. Provide and install portable data-loggers, if required.
z. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
aa. Oversee and approve the content and adequacy of the training of the Owner's operating personnel for commissioned equipment and systems.
bb. Compile and maintain a commissioning record and building systems book(s).

cc. Provide a final commissioning report.

1.8 SYSTEMS TO BE COMMISSIONED

A. The following systems will be commissioned in this project:

Equipment and System	Equipment and System
HVAC System	Equipment vibration control
Chillers	Egress pressurization
Pumps	
Cooling tower	
Fans	
Boilers	
Piping systems	
Ductwork	
Variable frequency drives	
Air handlers	
Packaged units (AC and HP)	
Terminal units (air)	
Unit heaters	
Heat exchangers	**Other**
Computer room units	Service water heaters
Fume hoods	Service water booster pumps
Lab room pressures	Refrigeration systems
Specialty fans	
Testing, Adjusting and Balancing work	
Chemical treatment systems	
HVAC control system	
Fire and smoke dampers	
Fan coil units	
Equipment sound control	

1.9 SUBMITTALS

A. All prefunctional checklists and functional performance verifications shall be completed and turned in to the CA.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the contractor for the equipment being tested. For example, the mechanical contractor shall ultimately be responsible for testing of equipment for the HVAC system and controls system except for equipment specific to and used by TAB in their commissioning responsibilities.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment shall be included in the base bid price to the Contractor and left on site, except for stand-alone data logging equipment that may be used by the CA.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in Paragraph 3.3.F. All equipment shall have been calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

A. Scoping Meeting. Within 90 days of notice to proceed, the CA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CA. Information gathered from this meeting will allow the CA to revise the Commissioning Plan to its "final" version, which will also be distributed to all parties.

B. Miscellaneous Meetings. Other meetings will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues. For large projects, these meetings may be held monthly, until the final 3 months of construction when they may be held as frequently as one per week.

3.2 REPORTING

A. The CA will provide regular reports with increasing frequency as construction and commissioning progresses.

B. The CA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

C. A final summary report by the CA will be provided to the PM, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

3.3 START-UP and PREFUNCTIONAL CHECKLISTS

A. The following procedures apply to all equipment to be commissioned. Some systems that are not comprised of dynamic machinery (e.g., electrical system power quality) may have very simplified Prefunctional checklists and startup.

B. General. Prefunctional checks are important to ensure that the equipment and systems are installed, connected, and operational. They ensure that functional performance verification (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full, prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance verification of equipment or subsystems of the given system. Prefunctional checklists must be completed by the contractor and approved by the CA before TAB work begins.

C. Start-up Plan. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. The CA shall ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

1. The CA creates the prefunctional checklists and procedures. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems.
2. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the checklist. A checklist may have more than one trade responsible for its execution.
3. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CA's checklists with the manufacturer's detailed start-up and checkout procedures from the IOM manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block.
4. The full start-up plan shall consist of:
   a. The CA's prefunctional checklists;
   b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end;
   c. The manufacturer's normally used field checkout sheets.
5. The subcontractor submits the full startup plan to the CA for review and approval.
6. The CA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
7. The full start-up procedures and the approval form may be provided to the PM for review and approval, depending on management protocol.

D. Sensor and Actuator Calibration.

1. All field-installed temperature, relative humidity, CO, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Owner before-hand. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
2. All procedures used shall be fully documented on the prefunctional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

E. Sensor Calibration Methods

1. All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
2. Sensors without Transmitters - Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
3. Sensors with Transmitters - Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
4. Critical Applications. For critical applications more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

F. Tolerances, Standard Applications

Sensor	Required Tolerance (+/-)	Sensor	Required Tolerance (+/-)
Cooling coil, chilled and condenser water temps	0.5F	Flow rates, water	4% of design
		Relative humidity	4% of design
AHU wet bulb or dew point	2.0F	Combustion flue temps	5.0F
Hot water coil and boiler water temp	1.5F	Oxygen or CO_2 monitor	0.1 % pts
Outside air, space air, duct air temps	0.5F	CO monitor	0.01 % pts
Watthour, voltage & amperage	1% of design	Natural gas and oil flow rate	1% of design
Pressures, air, water and gas	3% of design	Steam flow rate	3% of design
Flow rates, air	10% of design	Barometric pressure	0.1 in. of Hg

G. Valve and Damper Stroke Setup and Check

1. BAS Readout. For all valve and damper actuator positions checked, verify the actual position against the BAS readout.
2. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator.
3. Closure for heating coil valves (NO): Set heating set point 20°F above room temperature. Observe valve open. Remove power from the valve and verify that the

valve stem and actuator position do not change. Restore to normal. Set heating set point to 20°F below room temperature. Observe the valve close. Restore to normal.

4. Closure for cooling coil valves (NC): Set cooling set point 20°F above room temperature. Observe the valve close. Remove power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling set point to 20°F below room temperature. Observe valve open. Restore to normal.

H. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the GC and CA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. The CA shall be notified 48 hours prior to any startup. When checking off prefunctional checklists, signatures may be required of Subs for verification of completion of their work.
2. The CA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as approved by the CA). The CA will witness be at least four (if possible) on any one building, and no less than 20% of the total number of identical or very similar units.
3. For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the CA shall observe a sampling of the prefunctional and start-up procedures. The sampling procedures are identified in the commissioning plan. The CA will witness be at least four (if possible) on any one building, and no less than 20% of the total number of identical or very similar units.
4. The Subs and vendors shall execute startup and provide the CA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
5. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

I. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the checklist or on an attached sheet. The checklist and any outstanding deficiencies shall be provided to the CA within two days of test completion.
2. The CA reviews the report and submits either a non-compliance report or an approval form to the Sub. The CA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in within ten working days, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CA recommends approval of the execution of the checklists and startup of each system using a standard form.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

3.4 FUNCTIONAL PERFORMANCE VERIFICATION

A. This sub-section applies to all commissioning functional verification for all divisions.

B. The general list of equipment and systems to be commissioned is found in Paragraph 1.8. The specific equipment and modes to be tested are found in the Cx Plan.

C. The parties responsible to execute each test are listed with each test in the Cx Plan.

D. Objectives and Scope. The objective of functional performance verification is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional verification facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the verification process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested. Specific modes required in this project are given in the Cx Plan.

E. Development of Verification Procedures. Before test procedures are written, the CA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test shall provide assistance to the CA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CA shall provide a copy of the verification procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

F. The verification procedure forms developed by the CA shall include (but not be limited to) the following information:

1. System and equipment or component name(s)
2. Equipment location and ID number
3. Unique test ID number, and reference to unique prefunctional checklist and start-up documentation ID numbers for the piece of equipment
4. Date
5. Project name
6. Participating parties
7. A copy of the specification section describing the test requirements
8. A copy of the specific sequence of operations or other specified parameters being verified
9. Formulas used in any calculations
10. Required pre-test field measurements
11. Instructions for setting up the test
12. Special cautions, alarm limits, etc.
13. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
14. Acceptance criteria of proper performance with a Pass / Fail check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
15. A section for comments
16. Signatures and date block for the CA

G. Test Methods.

1. Functional performance verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The Cx Plan specifies which methods shall be used for each test.
2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hot air blower rather than overwriting the value or by altering the appropriate set point to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
5. Altering Set points. Rather than overwriting sensor values, and when simulating conditions is difficult, altering set points to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout set point to be 2F above the current outside air temperature.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
7. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
8. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. The specific sampling rates are specified with each type of equipment in the Cx Plan. It is noted that no sampling is allowed in prefunctional checklist execution.
9. A common sampling strategy referenced in the Specifications as the "xx% Sampling—yy% Failure Rule" is defined by the following example.
   a. xx = the percent of the group of identical equipment to be included in each sample.
   b. yy = the percent of the sample that if failing, will require another sample to be tested.
10. The example below describes a 20% Sampling—10% Failure Rule.

a. Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the "first sample."
b. If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).
c. If 10% of the units in the second sample fail, test all remaining units in the whole group.
d. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

H. Coordination and Scheduling. The Subs shall provide seven calendar days notice to the CA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CA will schedule functional tests through the GC and affected Subs. The CA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests. Functional testing shall be conducted after prefunctional testing and startup has been satisfactorily completed. The control system shall be sufficiently tested and approved by the CA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing shall be completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. After the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems will be checked.

3.5 DOCUMENTATION, NON-COMPLIANCE, AND APPROVAL OF TESTS

A. Documentation. The CA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the PM for review and approval and to the GC for review. The CA will include the filled out forms in the O&M manuals.

B. Non-Compliance.

1. The CA will record the results of the functional test on the procedure or test form. All non-compliance issues shall be noted and reported on a standard non-compliance form.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.
3. As tests progress and deficiencies are identified, the CA discusses the issue with the executing contractor.
   a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
      1) The CA documents the non-compliance and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CA submits the non-compliance reports to the PM for signature, if required. A copy is provided to the Sub and CA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CA.

2) The CA reschedules the test and the test is repeated.

b. If there is a dispute about a non-compliance, regarding whether it is a deficiency or who is responsible:

1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the PM and to the representative of the Sub that is assumed to be responsible.

2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final acceptance authority is with the Project Manager.

3) The CA documents the resolution process.

4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The CA reschedules the test and the test is repeated until satisfactory performance is achieved.

c. Refer to the sampling section of Paragraph 3.4.G.10 for requirements for testing and retesting identical equipment.

4. The Contractor shall respond in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

5. The CA retains the original non-conformance forms until the end of the project.

6. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.

7. Failure Due to Manufacturer Defect. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the PM. In such case, the Contractor shall provide the Owner with the following:

a. Within one week of notification from the PM, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the PM within two weeks of the original notice.

b. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.

c. The PM will determine whether a replacement of all identical units or a repair is acceptable.

d. Two examples of the proposed solution will be installed by the Contractor and test the installations for up to one week, upon which the PM will decide whether to accept the solution.

e. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

C. Approval. The CA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CA. The CA recommends

acceptance of each test to the PM using a standard form. The PM gives final approval on each test using the same form, providing a signed copy to the CA and the Contractor.

3.6 OPERATION AND MAINTENANCE MANUALS

A. Special requirements for the controls contractor and TAB contractor are found Section 23 08 10. Prior to substantial completion, the CA shall review the O&M manuals, documentation and redline as-builts for systems that were commissioned to verify compliance with the Specifications. The CA will communicate deficiencies in the manuals to the PM. Upon a successful review of the corrections, the CA recommends approval and acceptance of these sections of the O&M manuals to the PM. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated.

3.7 TRAINING OF OWNER PERSONNEL

A. Provide designated Owner personnel with comprehensive orientation and training, as requested by the Owner, in the understanding of the systems and the operation and maintenance of each piece of commissioned equipment.

B. In addition to these general requirements, the specific training requirements of Owner personnel by GC and vendors are specified in Section 01 82 00.

C. Planning and Scheduling

1. The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
2. The CA shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CA shall decide how rigorous the training should be for each piece of commissioned equipment. The CA shall communicate the results to the GC and vendors who have training responsibilities.
3. The CA develops an overall training plan and coordinates and schedules, with the GC, the overall training for the commissioned systems. The CA develops criteria for determining that the training was satisfactorily completed, including attending some of the training, etc. The CA recommends approval of the training using a standard form.
4. Each Sub and vendor responsible for training will submit a written training plan to the CA for review prior to training. The plan will cover the following elements:
   a. Equipment (included in training)
   b. Intended audience
   c. Location of training
   d. Objectives
   e. Subjects covered (description, duration of discussion, special methods, etc.)
   f. Duration of training on each subject
   g. Instructor for each subject
   h. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
   i. Instructor and qualifications
5. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.
6. Provide the CA with a training plan two weeks before the planned training.

D. Format

1. The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1-1989R, 1996 is recommended.
2. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
3. The appropriate trade or manufacturer's representative shall provide the instructions on each piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise, as well as in-depth knowledge of all modes of operation of the specific piece of equipment, is required. More than one party may be required to execute the training.
4. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
5. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
6. Training shall include:
   a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
   b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
   c. Discussion of relevant health and safety issues and concerns.
   d. Discussion of warranties and guarantees.
   e. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
   f. Discussion of any peculiarities of equipment installation or operation.
   g. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
   h. Explanation and demonstration of the operation, function, and overrides of any local packaged controls, not controlled by the central control system.
7. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

3.8 DEFERRED FUNCTIONAL PERFORMANCE VERIFICATION

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional performance verification may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system’s design) specified in Cx Plan shall be completed as part of this contract. The CA shall coordinate this activity. Tests will be executed, documented and

deficiencies corrected by the GC, with the CA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing will be made.

3.9 WRITTEN WORK PRODUCTS

A. The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan—Construction Phase, lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	**Developed By**
Final commissioning plan	CA
Meeting minutes	CA
Commissioning schedules	CA with GC
Equipment documentation submittals	GC
Sequence clarifications	Subs and A/E as needed
Prefunctional checklists	CA
Startup and initial checkout plan	GC and CA
Startup and initial checkout forms filled out	GC
Final TAB report	TAB
Issues log (deficiencies)	CA
Commissioning Progress Record	CA
Deficiency reports	CA
Functional test forms	CA
Filled out functional tests	CA
O&M manuals	GC
Commissioning record book	CA
Overall training plan	CA
Specific training agendas	GC
Final commissioning report	CA
Misc. approvals	CA

B. Commissioning Record.

1. Final Report Details. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: 1) Equipment meeting the equipment specifications, 2) Equipment installation, 3) Functional performance and efficiency, 4) Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used

(manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

2. Other documentation will be retained by the CA.

END OF SECTION 019113

SECTION 022200 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section requires the selective removal and subsequent offsite disposal of the following:
   1. Portions of existing interior construction indicated on drawings and as required to accommodate new construction.
   2. Removal of walls and interior partitions if indicated on Drawings.
   3. Removal of doors and frames indicated “remove”, or similar indication.
   4. Removal and protection of existing fixtures, materials, and equipment items indicated “salvage,” or otherwise to be re-used.

1.2 RELATED DOCUMENTS

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

B. Section 010590 - Special Conditions.

C. Section 017310 - Cutting and Patching.

D. Related work specified elsewhere:
   1. Remodeling, construction work, and patching are included within the respective sections of specifications, including removal of materials for reuse and incorporation into remodeling or new construction, and/or delivery of salvage
   2. Relocation of pipes, conduits, ducts, and other mechanical and electrical work if specified in other Divisions, and/or indicated on the Drawings.

1.3 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.

B. Schedule indicating proposed sequence of operations for selective demolition work to Contracting Officer’s Representative (COR) for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.
   1. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Government's on-site operations (i.e.: Work by others on behalf of the Government, normal work of Government's personnel and other building occupants, etc.).

1.4 JOB CONDITIONS

A. Occupancy: Government will occupy portions of the building or site immediately adjacent to areas of selective demolition. Conduct selective demolition work in a manner that will minimize need for disruption of Government's operations. Provide minimum of 72 hours advance notice to COR of demolition activities that will affect Government's operations.

B. Condition of Structures: Government assumes no responsibility for actual condition of items or structures to be demolished.

1. Conditions existing at time of inspection for bidding purposes will be maintained by Government insofar as practicable. However, minor variations within structure may occur by Government's removal and salvage operations prior to start of selective demolition work.

C. Partial Demolition and Removal: Items indicated to be removed but of salvageable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed.
   1. Storage or sale of removed items on site will not be permitted.

D. Protections: Provide temporary barricades and other forms of protection to protect Contractor's and Government's personnel and general public from injury due to selective demolition work.
   1. Provide protective measures as required to provide free and safe passage of personnel and representatives to portions of building and/or site, as required.
   2. Erect temporary covered passageways if required by authorities having jurisdiction.
   3. Provide interior bracing or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
   4. Protect from damage existing finish work that is to remain in place and which becomes exposed during demolition operations.
   5. Protect floors with suitable coverings when necessary.
   6. Construct temporary insulated dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
   7. Remove protections at completion of work, unless otherwise indicated on the drawings.

E. Damages: Promptly repair damages caused to adjacent facilities by demolition work.

F. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, building egress, and other adjacent occupied or used facilities.
   1. Do not close, block, or otherwise obstruct streets, walks, exit egress from building, or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

G. Flame Cutting: Do not use cutting torches for removal until work area is cleared of flammable materials. At concealed spaces, such as interior of ducts and pipe spaces, verify condition of hidden space before starting flame-cutting operations. Maintain portable fire suppression devices during flame-cutting operations.

H. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.
   1. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.
   2. Maintain fire protection services during selective demolition operations.

I. Environmental Controls: Use temporary enclosures and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.

PART 2 - PRODUCTS

2.1 Not applicable.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Provide interior bracing, or support to prevent movement, settlement, or collapse of areas to be demolished and adjacent facilities to remain.
   1. Cease operations and notify COR immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.

B. Cover and protect furniture, equipment, and fixtures from soilage or damage when demolition work is performed in areas where such items have not been removed.

C. Erect and maintain dust-proof partitions and closures, as required to prevent spread of dust or fumes to occupied portions of the building.

D. Locate, identify, stub off, and disconnect utility services that are not indicated to remain.
   1. Provide bypass connections as necessary to maintain continuity of service to occupied areas of building. Provide minimum of 72 hours advance notice to Owner if shutdown of service is necessary during changeover.

3.2 DEMOLITION

A. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
   1. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
   2. Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.
   3. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.

B. If unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to COR in written, accurate detail. Pending receipt of directive from COR, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

3.3 SALVAGED MATERIALS

A. Salvaged Items: Where indicated on Drawings as “Salvage - Deliver to Government,” or similar indication, carefully remove indicated items, clean, store, and turn over to Government and obtain receipt.
   1. Historic artifacts, including cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historic significance, remain property of Government. Notify COR if such items are encountered and obtain acceptance regarding method of removal and salvage for Government.
   2. Carefully remove, clean, and deliver to Government items so indicated in Section 010590 - “Special Conditions” and on the Drawings.

3.4 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from building site debris, rubbish, and other materials resulting from demolition operations.

Transport and legally dispose of off site.

1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
2. Burning of removed materials is not permitted on project site.

3.5 CLEANUP AND REPAIR

A. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protections and leave interior areas broom clean; vacuum carpets.
   1. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.
   2. Any protections to remain as noted on the plans shall be left in a clean and functional condition. Any protections to remain that are removed from the site or are no longer in a functional condition shall be replaced by the contractor or paid to the Government at two times (2x) the cost of replacement.

END OF 022200

SECTION 02 82 00 – ASBESTOS PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Procedure to be taken if Asbestos Containing Materials (ACM) identified on the drawings may be disturbed in the course of construction operations.

B. Procedure to be taken if material suspected of being ACM is encountered in the course of construction operations.

C. Procedure to be taken if work is required above ceilings where ACM is known or suspected to be present.

D. Procedure to be taken if ACM products are proposed for installation in new construction.

1.2 REFERENCES

A. 29 CFR 1910.1001 - OSHA Asbestos Standard for General Industry

B. B.29 CFR 1926.1101 - OSHA Asbestos Standard for the Construction Industry

C. C.40 CFR 61 Subpart M - NESHAP

D. 49 CFR 171, 172 & 173 - Department of Transportation (DOT)

1.3 RELATED SECTIONS

A. Section 01 06 50 “ENVIRONMENTAL COMPLIANCE”.

1.4 DEFINITIONS

A. Air Monitoring: The process of measuring the fiber content in a specific volume of air in a stated period of time.

B. Asbestos: Chrysotile, amosite, crocidolite, tremolite, anthophyllite and actinolite.

C. ACM: Asbestos Containing Material(s)

D. EEOH: Environmental Engineering and Occupational Health mission service contractor at MSFC.

E. Friable: Capable of being crumpled or reduced to powder by hand pressure.

F. ADEM: Alabama Department of Environmental Management

G. EPA: The Environmental Protection Agency

H. NESHAP: National Emission Standards for Hazardous Air Pollutants

I. OSHA: The Occupational Safety and Health Administration

J. Personal air monitoring: The process of monitoring the fiber content of air in the breathing zone of a worker performing asbestos related work.

1.5 SUBMITTALS

A. The contractor shall submit the following for all asbestos abatement work.

1. Asbestos Removal Plan

a. A detailed asbestos removal plan within 10 days after receipt of Notice of Award. The plan shall include location of asbestos control areas, location and layout of worker decontamination unit, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and encapsulant to be used. The plan shall be approved by the Contracting Officer prior to the start of any asbestos work.

2. Drawings showing Asbestos Abatement

a. Upon Completion of the project a marked up drawing or a floor plan showing where all asbestos was abated shall be submitted.

3. ADEM Notification

a. The contractor shall complete ADEM Form 496 and submit to ADEM 10 days prior to beginning any asbestos removal operations. In addition the contractor shall provide a copy of the ADEM Form 496 and some type of receipt showing ADEM received the form.

4. Copies of all Delivery Tickets

a. A copy of all delivery ticket(s), signed the by the RSAL operator, indicating that all RACM was appropriately disposed in accordance with above procedures including a Regulated Asbestos Material Waste Shipment Record (MSFC Form 4587) that was obtained from the MSFC Site Asbestos Coordinator.

B. The contractor shall also submit the following for all asbestos abatement work if he has never worked at MSFC or has not worked at MSFC in the last 2 years:

1. Training Records

a. Training records showing that all employees exposed to asbestos in excess of the permissible exposure limit have been trained in accordance with the requirements of 29 CFR 1926.1101 have obtained EPA accreditation in accordance with their duties. Contractor/Supervisor shall obtain Contractor/Supervisor accreditation and workers shall obtain worker accreditation.

2. Medical Examinations

a. A list of all employees that have received medical examinations as required by OSHA regulations (see 1010.134(b) (10) and 1926.1101). This list shall be updated if new employees are hired after work begins. Do not submit medical records.

3. Contractor Licenses/Certifications

a. A copy of the contractor's license to perform asbestos abatement

1.6 QUALITY ASSURANCE

A. Contractors performing work in areas containing ACM shall be qualified and accredited in accordance with OSHA, EPA, ADEM and other governing regulations.

B. Perform all work in accordance with OSHA, EPA, NESHAP, ADEM, MSFC Procedures, and other governing regulations.

C. Provide evidence acceptable to the COTR that workers in areas containing ACM or suspect ACM have been properly fitted with respirators and have been properly trained in accordance with 40 CFR part 61 (NESHAP), OSHA, EPA and other governing regulations.

D. The contractor shall be responsible for all personal, area and clearance monitoring. Monitoring shall be in accordance with EPA and OSHA guidance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 MATERIALS IDENTIFIED AS ACM

A. If ACM is identified on the drawings as a product in a known location and the ACM must be removed to accomplish the contract, the removal and disposal shall be a part of this contract unless otherwise specifically stated in the contract documents. Examples are: 1) Asbestos containing pipe insulation where the contract requires removal or reworking of the pipe; 2) Asbestos containing siding or roof deck which must be removed or penetrated as part of the contract.

B. If ACM is identified on the drawings as a product in the vicinity of construction operations and which may accidentally be disturbed during construction, the contractor shall provide protective measures approved by the COTR to prevent its disturbance.

1. Example: Asbestos containing pipe insulation on pipes which are not to be removed or reworked as part of this contract.

C. If friable ACM is identified on the drawings as being present above ceilings, proper procedures (specified herein) shall be used before removal of any portion of the ceiling.

1. Example: Sprayed ACM insulation or fireproofing on structure above a ceiling.

3.2 MATERIAL SUSPECTED OF BEING ACM

A. If an unidentified material is suspected of being ACM:

1. Do not disturb the suspect material.

2. Notify the COTR at once and await instructions. The COTR will arrange for sampling and testing by the EEOH and will provide instructions concerning barricades and warning signs, etc.

3.3 WORK ABOVE CEILINGS

A. If the contract requires any work above a ceiling or removal of a ceiling or portion of a ceiling where friable ACM is known to be or suspected to be present above or on the ceiling, the following procedures shall be followed:

1. Notify the CMI of impending operations as soon as practicable (but at least one week) before operations are to begin including a complete schedule for the work.

2. The CMI will arrange for HVAC and other utility outages and other coordination with the Government.

3. Separate the work area from occupied areas by installing "asbestos" warning barricade tape and posting "asbestos" warning signs at entrances to the work area.

4. Wear proper respiratory protection and protective clothing at all times while working in areas where asbestos may be disturbed.

5. Seal the work area as required by OSHA, NESHAP, EPA and other requirements. Seals shall remain until area is cleared and approved by the CMI.

6. Place 6 mil polyethylene over furniture and floor to collect debris that may fall from above the ceiling. Upon completion of each activity, remove the polyethylene and dispose of it as controlled waste. Ensure that no debris or dust will remain within the room. Remove dust and debris that may fall on furniture or floors using a vacuum equipped with a HEPA filter and properly dispose of the dust as controlled waste. No sweeping or dusting will be allowed. Use wet methods only.

3.4 REMOVAL / REPLACEMENT OF CEILINGS

A. In areas where asbestos-containing insulation or fireproofing is installed on the structure or deck above ceilings, asbestos-containing debris has been found on top of the existing ceilings.

B. Removal and disposal of ceiling tiles or ceiling systems in these areas is classified by OSHA as Class II abatement work and shall be performed by workers trained to perform OSHA Class II abatement work.

C. Where the project is limited to removal of a small quantity of ceiling tiles that can be placed in one glove bag or disposal bag, the work is classified by OSHA as Class III work and shall be performed by workers trained in OSHA Class III work.

3.5 REMOVAL OF ASBESTOS-CONTAINING FLOOR TILE

A. Asbestos-containing floor tile, sheet flooring, and mastic shall be removed in accordance with 29 CFR 1926.1101 (g)(8)(i) and other applicable regulations.

B. A utility outage shall be obtained prior to performing this work and the work shall be done after hours unless approval has been obtained from the CMI for work to be done during normal hours.

3.6 REMOVAL OF CARPET THAT IS INSTALLED OVER ASBESTOS-CONTAINING FLOORING

A. If carpet is required to be removed and the asbestos-containing flooring is not required to be removed, the following work practices shall be employed, as a minimum, to prevent excessive breakage of the flooring below:

1. Wet methods shall be used.

2. Carpet shall be cut into small strips and carefully removed so as to prevent breaking or pulling up the flooring.

3. Vacuums equipped with a HEPA filter and a disposable dust bag shall be used to collect dust from broken flooring as the carpet is removed.

4. All broken tile shall be placed in a disposable glove bag or waste bag for disposal. The area shall be thoroughly vacuumed of all dust and waste after removal of carpet prior to the completion of the job.

5. Areas where broken flooring is removed shall be filled with an approved floor filler prior to installing new carpet.

6. When the flooring under the carpet is intended to be used as the finished floor, clean the flooring using accepted methods. No sanding or use of a floor polisher with greater than 300 RPM shall be used. Remove all broken tiles and replace with approved tiles.

B. A utility outage shall be obtained prior to performing this work and the work shall be done after hours unless approval has been obtained from the CMI for work to be done during normal hours.

C. The Facilities Management Office has designated the removal of carpet installed over asbestos-containing flooring to be done in accordance with OSHA Class III requirements and procedures. The work shall be done by personnel trained and accredited for OSHA Class III work.

3.7 DISPOSAL OF REGULATED ASBESTOS CONTAINING MATERIAL (RACM)

A. Disposal of RACM shall be at the Redstone Army Landfill in accordance with their regulations. Packaging, labeling, delivery and unloading shall be in accordance with OSHA and RSAL regulations.

B. No RACM will be accepted at the RSAL without a Material Certification form, a delivery ticket, a copy of the ADEM Form 496, and a Regulated Asbestos Material Waste Shipment Record (MSFC Form 4587) obtained from the MSFC Site Asbestos Coordinator. All RACM will be clearly marked “FRIABLE ASBESTOS” on the delivery ticket.

C. No non-friable ACM will be accepted at the RSAL without a Material Certification form, a delivery ticket, and a copy of the ADEM Form 496. All non-friable ACM will be marked “NON-FRIABLE ASBESTOS” on the delivery ticket.

3.8 ASBESTOS AND NEW CONSTRUCTION.

A. Products containing asbestos shall not be used on projects governed by this specification without the approval of the Government. If the contractor elects to submit a product which contains asbestos for use on a project, the contractor shall identify the product as an “Asbestos Containing Material” (ACM), submit the MSDS sheet for the product which exhibits the asbestos content, and provide a justification for the use of the ACM product. The construction contractor shall provide an “Asbestos Free Statement” for new construction or documentation of where asbestos is located as a result of new construction.

END OF SECTION 028200

SECTION 02 83 00 - LEAD REMEDIATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surface preparation of steel which is painted with lead-containing paint.

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.

1. American National Standards Institute (ANSI)
2. ANSI Z88.2 - Respiratory Protection
3. Code Of Federal Regulations (CFR)

a. 29 CFR 1910.134 - Respiratory Protection
b. 29 CFR 1910.1200 - Hazard Communication
c. 29 CFR 1926. 62 - Lead - Construction Industry
d. 29 CFR 1926.57 - Ventilation
e. 29 CFR 1910.95 - Occupational Noise Exposure

B. Underwriters Laboratories Inc. (UL)

C. UL 586 High - Efficiency Particulate Air Filter Units

D. SSPC - The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222

E. SSPC Technical “Guide for Containing Surface Preparation Debris” Technical Guide No.6 Generated During Paint Removal Operations”

1.3 DEFINITIONS

A. Action Level

1. Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 - hour period.

B. Lead Control Area

1. An enclosed area or structure with full containment to prevent the spread of lead dust, paint chips, or debris of lead-containing paint removal operations. The lead control area shall be isolated by physical boundaries to prevent unauthorized entry of personnel.

C. Area Monitoring

1. Sampling of air to determine lead concentrations within the lead control area.

D. Physical Boundary

1. Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel.

E. Certified Industrial Hygienist (CIH)

1. As used in this section, refers to an Industrial Hygienist who is employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.

F. Change Rooms And Shower Facilities

1. Rooms within the designated physical boundary around the lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes to prevent cross-contamination.

G. Competent Person

1. Person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, state, and local regulations and has the authority to take prompt corrective actions to control the lead hazard. A Certified Industrial Hygienist (CIH) certified by the American Board of Industrial Hygiene or a Certified Safety professional (CSP) certified by the Board of Certified Safety Professionals is the best choice.

H. Decontamination Room

1. Room for removal of contaminated personal protective equipment (PPE).

I. Eight - Hour Time Weighted Average (TWA)

1. Airborne concentration of lead averaged over an 8 - hour period.

J. High Efficiency Particulate Air (Hepa) Filter Equipment

1. HEPA filtered vacuuming or exhaust ventilation equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

K. Lead

1. Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

L. Lead Control Area

1. A system of control methods to prevent the spread of lead dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.

M. lead permissible exposure limit (PEL)

1. Fifty micrograms per cubic meter of air as an 8 - hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula:

   PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.

N. Material Containing Lead/Paint With Lead

1. Any material, including paint, which contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint or MCL using laboratory instruments with specific limits of detection (usually 0.01%). An X-Ray Fluorescence (XRF) instrument used under the direction of the MSFC Environmental Engineering and Occupational Health Office is an acceptable method for testing for the presence of lead.

O. Personal Monitoring

1. Sampling of lead concentrations within the breathing zone of an employee to determine the 8 - hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

1.4 QUALITY ASSURANCE

A. In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling and storing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

B. Medical Examinations

1. Before exposure to lead-contaminate dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 and 29 CFR 1910.1200.

C. Medical Records

1. Maintain complete and accurate medical records of employees for a period of at least 40 years or for the duration of employment plus 20 years, whichever is longer.

D. Training

1. Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with 29 CFR 1910.1200.

2. Submit certifications signed and dated by the Contractor and by each employee stating that the employee has received training. Certify that the training course meets EPA requirements for the category of work assigned to the employee.

E. Respiratory Protection Program

1. Furnish each employee required to wear a negative pressure or other appropriate type respirator with a respirator fit test at the time of initial fitting and at least each year thereafter as required by 29 CFR 1926.62.
2. Establish and implement a respiratory protection program as required by 29 CFR 1910.134 and 29 CFR 1926.62.

F. Hazard Communication Program

1. Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.

1.5 SAFETY AND HEALTH COMPLIANCE

A. In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling and storing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

1.6 SUBMITTALS

A. SD-08: Manufacturer's instructions for use of paint removal materials including material safety data sheet (MSDS).

B. SD-01: Lead Compliance Plan - Submit a detailed, job-specific plan of the work procedures to be used in the disturbance and/or removal of Material Containing Lead/Paint with Lead. The plan shall be prepared by a certified planner/project designer in the State of Alabama. Include as a minimum the following:

1. Sketch showing the location, size and details of the control areas, critical barriers, physical boundaries, location and details of decontamination room, change room and shower facilities. Supplement with written description as required.
2. Detailed description of mechanical ventilation.
3. Description of equipment and materials, work practices, controls, and job responsibilities for each activity from which lead is emitted.
4. Eating, drinking, smoking, hygiene facilities and sanitary procedures.
5. Interface of trades and the sequencing of lead related work. This shall also include a description of arrangements made among contractors on multi-contractor worksites to inform affected employees and to clarify responsibilities to control exposures.
6. Procedures for waste water collection, if applicable.
7. Procedures to capture dust containing lead and debris, to include blast media when applicable.

8. Procedures to monitor air samples to include occupational and environmental sampling, training and strategy, sampling and analysis strategy and methodology, frequency of sampling, duration of sampling, and qualifications of sampling personnel.
9. Personal blood, respirator, and personal protective equipment (PPE) monitoring procedures.
10. Method of containment to ensure that airborne concentrations of lead do not exceed 30 micrograms per cubic meter of air outside the lead control area.
11. Site preparation, clean-up, and clearance procedures.
12. Identification and classification of wastes associated with the work.
13. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact.
14. Names and qualifications, to include experience and training, of personnel who will be working on-site with hazardous wastes.
15. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
16. Spill prevention, containment, and clean-up contingency measures.
17. Work plan and schedule for waste containment, removal, and disposal. Proper containment of waste includes using acceptable waste containers (e.g. 55-galn drums) as well as proper marking/labeling of containers. Wastes shall be cleaned up and containerized daily.
18. Include any process that may alter or treat waste rendering a hazardous was non-hazardous.

C. Certification of worker medical examinations

D. Certification of employee training

E. Employee exposure notification

F. Competent person qualifications

G. Lead waste management plan

H. Written evidence that treatment, storage, disposal facility is approved for lead disposal.

I. SD-01: Close-Out Submittals - Completed and signed waste delivery ticket(s)

PART 2 - PRODUCTS

2.1 PAINT REMOVAL PRODUCTS

A. Submit material safety data sheets (MSDS) for approval of paint removal products prior to use.

B. The soluble metal content and total metal content of abrasive materials shall not exceed values which would cause the material to be classified as hazardous waste.

2.2 EQUIPMENT

A. Have available for the A/E two complete sets of personal protective equipment (PPE) daily as required for entry into lead control area if needed. PPE shall include disposable whole body covering including foot, head, and hand protection.

B. Furnish workers appropriate NIOSH approved respirators for use in atmospheres containing lead dust. Comply with 29 CFR 1926.62 and 29 CFR 1910.134.

C. Furnish personal protective equipment (PPE) to workers exposed to lead-contaminated dust. PPE shall include whole body covering, foot covering and disposable plastic or rubber gloves. If protective clothing used for lead abatement work is to be laundered, a letter of communication from the contractor to the laundering facility indicating that lead-contaminated clothing will be delivered to the launderer shall be provided to the COTR prior to commencing work. Additionally, a letter from the laundering facility acknowledging they are receiving lead-contaminated clothing and stating that they are capable of receiving lead-contaminated clothing and have appropriate employee and environmental controls in place shall be received by the COTR prior to commencing work.

D. The government inspectors will provide their own respirators as required.

E. If rental equipment is used during lead-containing paint removal, handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Submit a copy of the notification to the A/E.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the facility and site to determine existing conditions.

B. The Contractor shall thoroughly clean the site of visible, existing Material Containing Lead/Paint with Lead that may be on the ground or in the proposed lead control area prior to the commencement of work.

C. Report conditions that differ from those described in the contract documents.

3.2 PROTECTION

A. Establish a lead control area around each work site where surface preparation is being performed.

B. If surface preparation operations produce exposure to lead dust in excess of the PEL, provide containment which, together with powered negative air pressure inside the enclosure, will prevent lead-containing dust from entering the atmosphere outside the lead control area and which shall facilitate collection of dust and debris for disposal. The containment enclosure may be localized or enclose the entire work area.

C. Provide a change room, shower facility and hand washing facility for personnel exiting from the lead control area.

D. Protect adjacent facilities and area from damage and contamination by lead-contaminated dust. Clean, repair and restore surroundings to original condition or better

E. Provide physical boundaries around work area designated on the drawings in accordance with 29 CFR 1926.62

3.3 MECHANICAL VENTILATION SYSTEM

A. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.57

B. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters approved by the A/E. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.

3.4 WARNING SIGNS

A. Provide warning signs at each approach to the lead control area. Follow 29 CFR 1926.62. Signs shall read:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

3.5 WORK PROCEDURES

A. Perform work in accordance with approved Lead Compliance Plan

B. Provide engineering controls to limit exposure to lead

C. Provide worker protection including work practice controls and administrative controls

D. Provide a CIH or "Competent Person" trained in lead abatement procedures, health effects of lead, OSHA and EPA regulations. The CIH or Competent Person shall be present while work is being performed and shall ensure that all regulations are being properly carried out. Such person shall have the authority to stop work and make proper corrections if improper or unsafe conditions occur.

3.6 INITIAL EXPOSURE ASSESSMENT

A. Prior to beginning work assume that the worker exposure to lead dust will be in excess of 50 micrograms per cubic meter (PEL).

B. Perform personal monitoring of employees within the lead control area representative of a full shift including at least one sample for each job classification in each work area either for each shift or for the shift with the highest exposure level. Follow 29 CFR 1926.62.

C. Until the actual exposure is determined by personal monitoring, provide interim protection in accordance with 29 CFR 1926.62 as follows:

1. Appropriate respiratory protection
2. Appropriate personal protective clothing
3. Change areas
4. Hand washing facilities
5. Biological monitoring to consist of blood sampling and analysis for lead and zinc protoporphyrin levels
6. Training
7. Hazard communication

3.7 CONTINUAL MONITORING

A. If initial monitoring indicates exposure to lead in excess of the PEL, perform continual monitoring as required by 29 CFR 1926.62.

B. Conduct additional monitoring whenever there is a change of equipment, process, control, personnel or a new task initiated.

3.8 EMPLOYEE NOTIFICATION

A. Within 5 working days after completion of the exposure assessment notify each employee in writing the results which represent that employee's exposure.

B. Follow 29 CFR 1926.62

3.9 HEARING PROTECTION

A. Provide hearing protection for employees exposed to noise levels in excess of 85 dBA over an 8 hour time weighted average.

B. Follow 29 CFR 1910.95

3.10 METHODS OF COMPLIANCE

A. Provide engineering and work practice controls including administrative controls to reduce and maintain employee exposure to lead to or below the PEL to the extent that such controls are feasible. Supplement the engineering controls by the use of respiratory protection complying with 29 CFR 1926.62.

B. Establish and implement a written compliance program to achieve compliance with these specifications.

C. Follow 29 CFR 1926.62.

3.11 PERSONNEL EXITING PROCEDURES

A. Whenever personnel exit the lead control area, ensure that they perform the following:

1. Vacuum themselves off with HEPA filtered vacuums
2. Remove protective clothing in the decontamination room and place them in an approved impermeable disposal bag.
3. Shower and wash hands and face
4. Change into clean clothing in the change room prior to leaving the physical boundary of the job site.

3.12 EATING FACILITIES

A. Provide a lead free environment area outside the lead control area for eating and drinking.

B. Prior to entering the eating area ensure that employees perform the personal exiting procedures listed above. Showering is not required except at the end of the shift.

C. Ensure that no eating, drinking, chewing or smoking is allowed within the lead control area or decontamination area.

3.13 MEDICAL SURVEILLANCE

A. Provide initial medical surveillance of employees including biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels prior to exposure to lead.

B. Provide continuing biological monitoring of employees exposed to lead in excess of the action level in accordance with 29 CFR 1926.62.

C. Temporarily remove employees whose blood lead level is at or above 50 microgram per deciliter of whole blood. Removal, medical surveillance and return of removed employees shall be in accordance with 29 CFR 1926.62 including required medical removal protection benefits.

3.14 SURFACE PREPARATION

A. Clean surfaces of dirt, loose rust, and other gross contamination by any method outlined in SSPC-SP 1, Solvent Cleaning, or pressure water washing.

B. Remove loose rust by SSPC-SP 2, Hand Tool Cleaning, or SSPC-SP 3, Power Tool Cleaning. Feather edges around rust spots to produce a smooth painted surface. When using methods SP 2 or SP 3, contain and collect paint dust and debris using vacuums equipped with HEPA filters.

C. Spot prime rusted areas immediately after removing loose rust applying the specified primer at the specified thickness.

D. Roughen the entire existing paint surface with abrasive paper, hand wire brushing, power wire brushing or other approved method to produce a tooth for adhesion of new paint as required by the specified coating system. Contain and collect paint dust by using vacuums equipped with a HEPA filter.

E. Manual or power sanding or grinding of lead surfaces or materials is not permitted unless tools are equipped with HEPA attachments or wet methods are used. The dry sanding or grinding of surfaces that contain lead is prohibited. Provide methodology for removing lead in the Lead Compliance Plan.

3.15 INSPECTION

A. Notify the Government Inspector when surfaces are ready for inspection at the following stages of preparation:

1. After removing rust before spot priming
2. After final surface preparation before applying finish coating system

B. Do not proceed until approved by the Government Inspector.

3.16 ALTERNATE SURFACE PREPARATION

A. Rust may be removed and existing paint surface roughened by method SSPC-SP 7, Brush-off Blast Cleaning, provided the following are met:

1. Contain and collect abrasives, paint dust and debris using a closed cycle vacuum recovery system equipped with HEPA filters.
2. Handle and dispose of abrasives, paint dust and debris as specified in Section 01 60 50 “Exterior Performance Requirements”.
3. Ensure that no visible emissions of lead-containing dust escape the enclosed vacuum recovery system.
4. Place two layers of 6 mil polyethylene under each work area extended twenty feet minimum beyond the work area in all directions to collect dust and debris that may escape the enclosed recovery system. Remove and dispose of the top layer as hazardous waste at the end of each shift. Contain and protect hazardous materials from escaping the lead control area due to wind or other means. Remove both layers of polyethylene upon completion.

3.17 CLEAN - UP

A. Maintain surfaces of the lead control area free of accumulation of dust and debris. Restrict the spread of dust and debris; keep waste from being distributed over the work area.

B. Do not dry sweep or use pressurized air to clean up the lead control area.

C. At end of each shift and when the lead operation has been completed, clean the controlled area of visible contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area, and wet wiping the area as indicated by the Lead Compliance Plan. After visible dust and debris is removed, wet wipe and HEPA vacuum all surfaces in the controlled area.

D. If adjacent areas become contaminated at any time during the work process - clean, visually inspect, and then wipe sample all contaminated areas.

E. For phased construction, clean each phase as completed.

F. The competent person shall submit certification in writing that the area has been cleaned of lead contamination prior to clearance testing. Clearance testing to be accomplished per the Lead Compliance Plan.

3.18 DISPOSAL

A. All material, whether hazardous or non-hazardous, shall be disposed of in accordance with all laws and provisions and all federal, State, or local regulations. Ensure all waste is properly characterized. The result of each waste characterization (Toxicity Characteristic Leaching Procedure for Resource Conservation and Recovery Act materials) will dictate disposal requirements.

B. At the end of each day's work or prior to leaving the work site, the Contractor shall segregate waste. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and clothing that may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 262. Contractor shall furnish containers unless otherwise noted on the drawings that the Government will provide the containers. For Government provided containers, the Government will remove and properly dispose of containers as controlled or hazardous waste.

C. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. For hazardous waste, the collection drums shall be marked and labeled in accordance with 40 CFR 262 during the accumulation and collection time frame. The Contracting Officer or authorized representative will assign an area for interim storage of the waste-containing drums. Drums containing hazardous waste shall not be maintained in interim storage longer than 90 calendar days from the date affixed to each drum.

D. For Contractor provided containers, dispose of lead-contaminated material classified as hazardous waste at an approved hazardous waste treatment, storage, or disposal facility off Government property.

3.19 HANDLING, DUST CONTROL, AND DISPOSITION OF LEAD COATINGS

A. The following requirements, except as noted in Paragraph entitled “Requirements for Removing Lead Coatings- Small Scale / Short Duration,” shown below, apply to all work performed in connection with the removal of lead-based coatings or materials coated with the lead-based materials:

1. Worker protection and work practices shall conform with OSHA Safety and Health Standards, 29 CFR 1926.62.
2. Methods utilized to remove lead-based coatings shall minimize the amount of dust generated, and shall be in accordance with the Contractor’s approved lead coatings safety plan. Engineering controls shall be employed to insure that airborne lead exposures do not exceed 50 micrograms / cubic meter. Contaminated air shall be filtered before it is discharged into the environment away from the source of intake air, in accordance with 29 CFR 1926.353.
3. All workers in the controlled lead abatement area shall wear NIOSH approved respirators with high efficiency filters and protective clothing as required by 29 CFR 1926.62. Use of respirators shall comply with 29 CFR 1910.134. All lead particulate and waste shall

be collected and sealed in non-permeable accumulation containers in accordance with article 2.01 of this Section.

4. The Contractor shall submit a written detailed plan, for approval, which describes the methods and equipment to be used to achieve the lead removal in conformance with the requirements listed above. This submittal shall, as a minimum, include the following:

   a. Removal, containment and/or ventilation plans and drawings
   b. Plan for protection of ambient air, soil and water
   c. Worker protection programs
   d. Plan for handling and disposal of debris

3.20 REQUIREMENTS FOR REMOVING LEAD COATINGS- SMALL SCALE/SHORT DURATION

A. The following minimum requirements shall be followed when removing material by grinding, cutting, or welding, which is attached to the steel structure.

1. Comply with 29 CFR 1926.62.
2. Local exhaust shall be used to ventilate the area during welding, cutting, or burning of lead coatings.
3. Personnel required to conduct welding, cutting, or burning of lead coatings, as a minimum, shall be outfitted with a powered air purifying respirator (PAPR) equipped with high efficiency filter. Under certain conditions, i.e. poor ventilation, supplied air respiratory protection may be required.
4. Personnel required to conduct welding, cutting, or burning of lead coatings shall wear protective clothing. Contractors shall arrange for the laundering of protective clothing; or, if disposable protective clothing is used, the Contractor shall maintain an adequate supply at the worksite and arrange for its safe disposal according to applicable Federal (40 CFR 260) and State regulations.
5. Following welding, cutting, or burning of lead coatings, employees must exercise good personal hygiene (i.e., washing hands and face) since lead can become an ingestion hazard.

END OF SECTION 02 83 00

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Slabs-on-grade.
2. Equipment bases

1.3 DEFINITIONS

Cementitious Materials: Portland cement alone or in combination with fly ash and other pozzolans, subject to compliance with requirements.

1.4 SUBMITTALS

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

a. Include statement indicating costs for each product having recycled content.

B. Design Mixtures: For each concrete mixture.

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. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Curing compounds.

1.5 QUALITY ASSURANCE

A. 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."

B. Testing Agency Qualifications: An independent agency 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, 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.

C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete."

2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will 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:

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. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Wire: ASTM A 82, as drawn.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut bars 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:

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I.

a. Fly Ash: ASTM C 618, Class C.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will 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.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

2.6 VAPOR RETARDERS

Reinforced Vapor Retarders:

1. 3-Ply laminate, consisting of two layers of high-density polyethylene and one layer of high-strength non-woven cord grid.
2. Weight, ASTM D 3776: 37 lb/1,000 SF.
3. Puncture Propagation Tear, ASTM D 2582: 28 LBF.
4. Permeance (Perm), ASTM E 96: 0.038 grains/hr-ft2-in Hg.
5. Drop Dart, ASTM D 1709 Method B: 500 g.
6. Tensile Strength, 3 Inches, ASTM D 882: 96 lb/5,442 psi.
7. Puncture Strength, ASTM D 4833: 24 LBF.
8. Classification, ASTM DE 1745: Class C.
9. Usable Temperature Range: -25 to 170 degrees F.

2.7 FLOOR AND SLAB TREATMENTS

Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; 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. (305 g/sq. m) 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.

2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.10 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 concrete supplier 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.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing 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.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

Equipment Bases and Slabs on Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches.
4. Air Content: 4 percent.

2.12 FABRICATING REINFORCEMENT

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

2.13 CONCRETE MIXING

Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 FORMWORK

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.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Chamfer exterior corners and edges of permanently exposed concrete.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

G. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items.

1. Install anchor rods, accurately located, to elevations required.

3.3 REMOVING AND REUSING FORMS

Clean and repair surfaces of forms to be reused in the Work. Apply new form-release agent.

3.4 VAPOR RETARDERS

Reinforced Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions. Lap joints 6 inches and seal with manufacturer's recommended tape. Seal around pipes and other penetrations in vapor retarder in accordance with manufacturer’s written instructions.

3.5 STEEL REINFORCEMENT

A. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

B. 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.

C. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

D. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to

minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Contraction Joints in Slabs-on-Grade: 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. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

C. Isolation Joints in Slabs-on-Grade: 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. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

D. 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 have been performed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness.

1. Consolidate placed concrete with mechanical vibrating equipment.
2. 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.

C. 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.

D. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. Ambient temperature must be at least 40 degrees and rising at time of placement.

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 chemical accelerators unless otherwise specified and approved in mixture designs.

E. Hot-Weather Placement: Comply with ACI 301 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.
2. Just before placing concrete, keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

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.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, 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 restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to be covered with fluid-applied or sheet waterproofing.

C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and 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.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. 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: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and 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 301 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 before and during finishing operations. Apply according to manufacturer's written instructions.

C. Cure concrete by one or a combination of the following methods:

1. 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.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENTS

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.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when required by COR. Remove and replace concrete that cannot be repaired and patched to COR’s approval.

B. Perform structural repairs of concrete, subject to COR's approval, using epoxy adhesive and patching mortar.

3.15 FIELD QUALITY CONTROL

A. Testing: Contractor will engage a qualified testing agency to perform field tests and prepare test reports.

B. Inspecting: Provided by the Contractor's Quality Assurance Representative.

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.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample (set of 4 cylinders) for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
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, 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 and when 80 deg F and above.
5. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

6. 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.

7. 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.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength.
9. Test results shall be reported in writing to Government COR, concrete manufacturer, and Contractor within 48 hours of testing.
10. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 033000

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2. DESCRIPTION OF WORK:

A. Work described in this Section includes:

1. Through penetration firestopping in fire rated construction.
2. Construction-gap firestopping at connections of the same materials and different materials in fire rated construction.
3. Construction-gap fire stopping occurring within fire rated wall, floor, floor-ceiling, and/or roof-ceiling assemblies.
4. Construction-gap firestopping at the top of fire rated walls.
5. Through-penetration smoke-stopping in smoke partitions.
6. Construction-gap smoke-stopping in smoke partitions.

B. Related work Specified elsewhere includes:

1. For structural, finish, and fire protection materials: Refer to the appropriate Specifications Sections.
2. Fire dampers and manufactured devices: Refer to Division 22.
3. Raceway seals and manufactured electrical devices: Refer to Division 26.

C. Unless specifically indicated otherwise, the party, trade, or subcontractor whose work penetrates fire-rated construction and/or fire-rated assemblies, shall be responsible for firestopping around their own penetrations.

D. In the event the General Contractor employs a Specialty Subcontractor for the required firestopping work, they shall notify all prospective Bidders, so as to avoid duplication in pricing.

1. The Specialty Subcontractor shall provide coordination of requirements and the related work of other trades in advance of and as the Work progresses.

1.3 REFERENCED STANDARDS:

A. Underwriters Laboratories - U.L. Fire Resistant Directory:

1. Through-penetration fire stop devices (XHCR).
2. Fire resistant ratings (BXUV).
3. Through-penetration firestop systems (XHEZ).
4. Fill, void, or cavity material (XHHW).

B. American Society for Testing and Materials Standards:

1. ASTM E 814: Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
2. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories, Inc.:

1. UL 1479: Fire Tests of Through-Penetration Firestops.
2. UL 723: Surface Burning Characteristics of Building Materials.

1.4 DEFINITIONS:

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time rated fire walls, smoke barrier walls, time rated floor-ceiling and roof-ceiling assemblies, and structural floors and walls.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses, and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.

F. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc., to close specific barrier penetrations.

G. Sleeve: Metal fabrication or metal pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.5 SYSTEM DESCRIPTION:

A. Design Requirements:

1. Fire Rated Construction: Maintain barrier and structural floor fire ratings including resistance to cold smoke at all penetrations, connections with other surfaces and/or types of construction, at separations required to permit building movement and sound and/or vibration absorption, and at other construction gaps.
2. Smoke Barrier Construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction and at all separations required to permit building movement and sound and/or vibration absorption, and at other construction gaps.

1.6 SUBMITTALS:

A. Submit in accordance with General Conditions and Division 1, unless specifically indicated otherwise.

B. Product Data: Manufacturer's written specifications and technical data including the following:

1. Detailed specifications of construction and fabrication.
2. Manufacturer's current written installation instructions.
3. Summary of test data for each product intended for use and limitations.

1.7 QUALITY ASSURANCE:

A. Specialty Contractor's Qualifications: Firm experience in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, and to State, Local, and/or other authority having jurisdiction, where applicable.
2. At least 2-years experience with systems intended for use.
3. Successfully completed at least five projects of similar size, scope, and complexity using the systems intended for use.

B. Local and State Regulatory Requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System Numbers or UL classified devices and/or systems.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

1.8 DELIVERY, STORAGE AND HANDLING:

A. Packing and Shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Coordinate delivery with scheduled installation date, so as to allow minimum storage at site.

B. Storage and Protection: Store materials in a clean, dry, ventilated interior location. Store materials off of floor, and protect from soiling, abuse, moisture, and freezing. Follow manufacturer's written instructions when more stringent.

C. Remove damaged and/or contaminated materials immediately, legally dispose of off site, and Replace, at Contractor's expense.

1.9 PROJECT CONDITIONS:

A. Existing Conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding with work.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental Requirements:

1. Furnish adequate ventilation if using solvents.
2. Furnish forced air ventilation during installation if required by manufacturer and/or authorities having jurisdiction.
3. Keep Flammable materials away from sparks or flame.
4. Provide masking or drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
5. Comply with manufacturer's written recommendations for temperature and humidity conditions before, during, and after installation of firestopping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND PRODUCTS:

A. Use only those listed in the UL Fire Resistance Directory for the UL System involved.

B. Products shall be as manufactured by one of the following, or pre-approved equivalent:

1. Dow Corning.
2. HILTI.
3. 3M Fire Protection Products.
4. Nelson Firestop Products.
5. Rector Seal Corp.
6. Specified Technologies, Inc.
7. Tremco, Div. of RPM Corporation.

C. All firestopping products must be from a single manufacturer.

D. All trades shall use products from the same manufacturer.

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION:

A. Systems or devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that they conform to the construction type, penetrant type, annular space requirements, and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designated to perform this function.

2.3 CONSTRUCTION-GAP FIRESTOPPING OF FIRE-RATED CONSTRUCTION:

A. Firestopping at construction gaps between edges of floor slabs and exterior wall construction.

B. Firestopping at construction gaps between tops of partitions and under side of structural systems.

C. Firestopping at construction gaps between tops of partitions and underside of fire-rated ceiling or ceiling assembly.

D. Firestopping of control joints in fire rated masonry partitions.

E. Firestopping expansion joints.

F. Acceptable manufacturers and products: Use only those listed in the UL Fire Resistant Directory for the UL System involved.

2.4 SMOKE STOPPING AT SMOKE PARTITIONS:

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in the "Referenced Standards" is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded, as applicable.

B. Construction-gap smoke-stopping: Any system complying with the requirement for construction-gap firestopping in fire-rated construction, as specified in the "Referenced Standards" is acceptable, provided that the system includes the specified smoke seal or will provide the smoke seal. The length of time of the fire resistance may be disregarded, as applicable.

2.5 ACCESSORIES:

A. Fill, void, and cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.
B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion. Notify the General Contractor of such conditions.

1. Verify barrier penetrations are properly sized and in suitable conditions for application of materials.
2. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 PREPARATION AND CLEANING:

A. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust or other substances, that may effect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION:

A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's written instructions and recommendations.

B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

C. Where floor openings without penetrating items are more than 4-inches in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as required for floor system.

D. Protect materials from damage on surfaces subject to traffic.

E. Place firestopping in annular space around fire dampers before installation of damper's anchoring flanges, which are to be installed in accordance with fire damper manufacturer's written recommendations, unless specifically indicated otherwise.

F. Where large openings are created in walls, or floors to permit installation of pipes, ducts, cable tray, bus duct, or other items, close unused portions of opening with firestopping material tested for the application.

G. Install smoke firestopping as specified for firestopping.

H. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical, 12-inch wide fiber dams for full thickness and height of air cavity at maximum intervals of 15'-0" on center.

3.4 FIELD QUALITY CONTROL:

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by the Architect, building inspector, fire inspector, and/or other authority having jurisdiction.

C. Perform under this Section 078413, patching and repairing of firestopping caused by cutting or penetration by other trades, and/or by any other cause.

3.5 ADJUSTING AND CLEANING:

A. Immediately clean-up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged and clean condition.

D. Legally dispose of excess materials, trash, debris, etc., off of site.

END OF 078413

SECTION 07 90 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Sealants and joint backing.

1.2 RELATED REQUIREMENTS

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

B. Section 078413 – Penetration Firestopping: Firestopping sealants.

1.3 REFERENCE STANDARDS

A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2011.

B. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2011a.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with other sections referencing this section.

1.5 SUBMITTALS

A. See Section 013300 – “Submittal Procedures”, for submittal procedures.

B. Product Data: Provide data indicating sealant chemical characteristics.

C. Samples: Submit two samples, 6 by 6 inch in size illustrating sealant colors for selection.

D. Submit results of field sealant adhesion testing to Architect prior to start of work.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.

1.7 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.8 WARRANTY

A. See Section 017700 - Closeout Procedures, for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories which fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 – PRODUCTS

2.1 MANUFACTURERS/PRODUCTS

A. Type 1 - Silicone Sealants:
   1. Pecora Corporation; 890NST Ultra Low Modulus Architectural Silicone Sealant - Class 100: www.pecora.com.
   2. Dow Corning; Product 790: www.dowcorning.com.
   3. Tremco Global Sealants; Product Spectrem 1: www.tremcosealants.com.

B. Type 2 - Silicone Sealants:
   1. Dow Corning; Product 795: www.dowcorning.com.
   2. Pecora Corporation; Product 895: www.pecora.com.
   3. Tremco Global Sealants; Product Spectrem 2: www.tremcosealants.com.
   4. Substitutions: See Section 01600 - Product Requirements.

C. Type 3 - Polyurethane Sealants:
   1. Sika Corporation; Product Sika Flex 2C: usa.sika.com.
   2. Sonneborn by BASF; Product Sonolastic NP-2: www.buildingsystems.basf.com.
   3. Tremco; Dymeric 240 FC: www:tremcosealants.com.

D. Acrylic Sealants (ASTM C920):
   1. Tremco Global Sealants: www.tremcosealants.com.
   2. Red Devil; Siliconized Acrylic Construction Grade (35 Year) Sealant: www.reddevil.com.
   3. Sherwin-Williams Company; Shermax Urethanized Elastomeric Sealant: www.sherwin-williams.com.

E. Butyl Sealants:
   1. Bostik Inc: www.bostik-us.com.
   2. Pecora Corporation: www.pecora.com.
   3. Sherwin-Williams Company; Storm Blaster All Season Sealant: www.sherwin-williams.com.
   4. Tremco Global Sealants: www.tremcosealants.com.
   5. Substitutions: See Section 016000 - Product Requirements.

2.2 SEALANTS

A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

B. Use silicone sealants at all exterior joints.

C. Type 1 - Silicone Sealant: Ultra low-modulus, high-performance, one-part, moisture-curing silicone joint sealant. ASTM C920, Type S, Grade NS, Class 100/50, Uses NT, A, G, M, O; single component.
   1. Color: To be selected by Architect from manufacturer's standard range.
   2. Applications: Use for: Masonry-to-masonry, or masonry-to-stone joints.

D. Type 2 - Silicone Sealant: Medium modulus, one-part, high-performance, neutral-cure silicone sealant. ASTM C920, Type S, Grade NS, Class 50, Uses NT, A, G, M, O; single component.
   1. Color: To be selected by Architect from manufacturer's standard range.
   2. Applications: Use for: Metal-to-metal, or Window/louvers-to-masonry joints.

E. Type 3 - Polyurethane Sealant: ASTM C920, Type M, Grade NS, Class 50, Uses NT, I, (Class 2), M, A; multi component, chemical curing, capable of continuous water immersion, non-sagging type.
   1. Color: To be selected by Architect from manufacturer's standard range.
   2. Applications: Use for: Concrete block-to-concrete block, or concrete block-to-poured in place concrete in cavity wall construction. Joints and penetrations in vertical and horizontal surfaces of concrete, and between metal and concrete, mortar or stone; overhead or ceiling joints; perimeters of metal frames; vertical expansion and control joints in masonry and concrete; and at all miscellaneous locations requiring a joint sealant.

F. Type 4 - Acoustic Sealant: Butyl or acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
   1. Applications: Use for concealed locations only: Sealant bead between top stud runner and structure, and between bottom stud track and floor.

2.3 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Protect elements surrounding the work of this section from damage or disfigurement.

3.3 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Install bond breaker where joint backing is not used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Tool joints concave.

3.4 FIELD QUALITY CONTROL

A. Perform field sealant testing for all sealants that affect watertightness.

1. Test each material scheduled as a substrate for silicone sealants to verify substrate priming and preparation requirements.
2. Field sealant adhesion testing shall be performed by authorized representative of selected sealant manufacturer.
3. Submit results of field sealant adhesion testing to Architect prior to start of work.
4. Coordinate results of testing so that substrate preparation and priming requirements are known at time when needed by sealant applicator before sealant installation.

3.5 CLEANING

Clean adjacent soiled surfaces.

3.6 PROTECTION

Protect sealants until cured.

END OF 079000

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Related work specified elsewhere includes:

1. Section 079000 - "Joint Sealers" (sealing expansion joints in tile work)

1.2 DESCRIPTION OF WORK

A. Definition: Tile includes ceramic surfacing units made from clay or other ceramic materials.

B. Extent of tile work, product selections, sizes and colors as indicated on drawings and schedules. Provide grout setting bed sloped to floor drains at locations where recessed slabs are indicated.

C. Types of tile work in this section include the following:

1. Porcelain ceramic tile flooring. wall tile, coved base, and trim, with polished brass strip at perimeter edges of each tile flooring panel, except where abuts a wall, permanent built-in cabinet, stone threshold, etc., and as otherwise indicated on the Drawings.

   a. Special metal edge trim, where indicated.
   b. Patterns as indicated, or if not indicated, checkerboard pattern and/or borders, as directed by the Architect.

3. Stone thresholds, where indicated.
4. Colored grouts.
5. Waterproofing membrane below all floor tile work.

D. Chemical Resistant Epoxy grout installation system is required at entire are within Toilet and Shower Rooms and, at Janitor's Rooms.

E. Note that all tile flooring, base, and wall tile specified herein shall be installed with grouted joints, also as specified.

1.3 QUALITY ASSURANCE

A. Source of Materials: Provide materials obtained from one source for each type and color of tile, grout, and setting materials.

B. Installer Qualifications: Engage an experienced installer who has successfully completed tile installations similar in material, design, and extent to that indicated for this Project.

C. Flooring/Walkway Products: Products and installation, surfaces' co-efficient of friction (slip-resistance), etc., under the work of this Section shall be in compliance with the more stringent of applicable provisions of the following; And revisions and amendments thereto:

1. Published U. S. Justice Department Regulations for the “Americans with Disabilities Act of 1990” (ADA; ADA-AG);
2. “2010 ADA Standards for Accessible Design”, Published in the Federal Register September 15, 2010, and revisions and amendments thereto.
3. ANSI A117.1;
4. “Uniform Federal Accessibility Standards” (UFAS);
5. International Building Code, as applicable at the project locale.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s technical information and installation instructions for materials required, except bulk materials.

B. Shop Drawings: Submit shop drawings indicating tile patterns and locations and widths of control, isolation, contraction and expansion joints in tile surfaces.

C. Samples for Initial Selection Purposes: Submit manufacturer’s color charts consisting of actual stone and tiles or sections of tile showing full range of colors, textures and patterns available for each type of tile indicated. Include samples of grout and accessories involving color selection.

D. Samples for Verification Purposes, submit the following upon request by Architect:

1. Samples for each type of stone and tile and for each color and texture required, not less than 12-inches square, on plywood or hardboard backing and grouted.
2. Full size samples for each type of trim, accessory and for each color.
3. 6-inch long samples of stone thresholds.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Prevent damage or contamination to materials by water, freezing, foreign matter or other causes.

1. Comply with requirements of ANSI A137.1 for labeling sealed tile packages.

B. Refer to Division 1 Sections “Product Requirements” for additional information and requirements regarding stored materials.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer’s printed recommendations.

B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

C. Maintain temperatures at not less than 50 degrees F (10 degrees C) in tiled areas during installation and for 7-days after completion, unless higher temperatures are required by referenced installation standard and/or tile and grout manufacturers’ current written instructions and recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following manufacturers, to include any additional manufacturers listed on Finish Schedules:

1. Manufacturers of Porcelain Ceramic Tile:

   a. American Olean Tile Co., Inc.
   b. Crossville Ceramics
   c. Dal-Tile Corp.
   d. Summitville Tiles, Inc.

2. Manufacturers of Glazed Tile:

   a. American Olean Tile Co., Inc.
   b. Dal-Tile Corp.
   c. Summitville Tiles, Inc.

3. Manufacturers of Latex-Portland Cement Mortars:

   a. American Olean Tile Co., Inc.
   b. H. B. Fuller Co.
   c. Summitville Tiles, Inc.
   d. W. R. Bonsal Co.

4. Manufacturers of Organic Adhesives, Type I:

   a. Boiardi Products Corp.
   b. Cambridge Tile Mfg. Co.
   c. Custom Building Products.
   d. C-Cure Chemical Co., Inc.
   e. H. B. Fuller Co.
   f. Jamo, Inc.
   g. L & M Surco Mfg., Inc.
   h. Southern Grouts & Mortars, Inc.
   i. Syracuse Adhesives Co.
   j. Upco Co. Div., Emhart Corp.

5. Manufacturers of Latex-Portland Cement Grouts:

   a. Boiardi Products Corp.
   b. Cambridge Tile Mfg. Co.
   c. Custom Building Products.
   d. C-Cure Chemical Co., Inc.
   e. H. B. Fuller Co.
   f. Jamo, Inc.
   g. L & M Surco Mfg., Inc.
   h. Southern Grouts & Mortars, Inc.
   i. Syracuse Adhesives Co.
   j. Upco Co. Div., Emhart Corp.

k. W. R. Bonsal Co.

6. Manufacturers of Chemical Resistant Epoxy Grouts:

a. Atlas Minerals & Chemicals, Inc.
b. Boiardi Products Corp.
c. Cambridge Tile Mfg. Co.
d. C-Cure Chemical Co., Inc.
e. H. B. Fuller Co.
f. L & M Surco Mfg., Inc.
g. Laticrete International, Inc.
h. Southern Grouts & Mortars, Inc.
i. Summitville Tiles, Inc.
j. Syracuse Adhesives Co.
k. Upco Co. Div., Emhart Corp.

7. Manufacturers of Chemical-Resistant Joint Sealants:

a. Atlas Minerals and Chemical Co.
b. Pennwalt Corporation.

8. Manufacturers of Tile Cleaners:

a. Hillyard Chemical Co.
b. L & M Surco Mfg. Co., Inc.

9. Manufacturers of Special Metal Trim and Nosings:

a. Schluter Systems, L.P.

2.2 PRODUCTS - GENERAL

A. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1 “American National Standard Specifications for Ceramic Tile” for types and grades of tile indicated.

1. Furnish tile complying with “Standard Grade” requirements unless otherwise indicated.

B. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.

C. Colors, Textures and Patterns: For tile, grout and other products requiring selection of colors, surface textures or other appearance characteristics, provide products to match characteristics indicated or, if not otherwise indicated, as selected by Architect from manufacturer’s standards.

1. Provide tile trim and accessories which match color and finish of adjoining flat tile, unless otherwise indicated.

D. Mounting: Where factory-mounted tile is required provide back or edge-mounted tile assemblies as standard with manufacturer unless another mounting method is indicated.

1. Where tile is indicated for installation, on exteriors or in wet areas, do not use back or edge-mounted tile assemblies unless tile manufacturer specifies that this type of mounting is suitable for these kinds of use and has been successfully used on other projects.

2.3 CERAMIC TILE PRODUCTS

A. Porcelain Ceramic Floor Tile: Provide flat tile complying with the following requirements:

1. Product/Manufacturer: As indicated on the Drawings.
2. Wearing Surface: Provide manufacturer's standard finish for named products, as indicated, and compliant with ADA-AG, or if not indicated, as selected by Architect.
3. Nominal Facial Dimensions: As indicated on the Drawings, or if not indicated, no less than 12" x 12"; And any related tile and special metal trim where indicated.
4. Nominal Thickness: 5/16-inch, unless otherwise indicated.
5. Face: Plain with cushion or square edges, unless otherwise indicated.
6. Colors: As indicated on the Drawings, or if not indicated, as selected by Architect from manufacturer's full line of standard colors and color groups, after Bid Date.

B. Glazed Wall Tile: Provide flat tile complying with the following requirements, unless otherwise indicated on the Drawings:

1. Nominal Facial Dimensions: As indicated on the Drawings; And any related trim where indicated.
2. Nominal Thickness: 5/16-inches, unless otherwise indicated.
3. Face: Plain with modified square edge, or cushion edge.
4. Colors: As indicated on the Drawings, or if not indicated, no less than 4" x 4" or 6" x 6", as selected by Architect from manufacturer's full line of standard colors, after Bid Date, and all related tile trim.
5. Locations: At locations indicated on the Drawings.

C. Trim Units: Provide tile trim units, if indicated, to match characteristics of adjoining flat tile and to comply with following requirements:

1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile, where applicable.
2. Shapes: As follows, selected from manufacturer's standard shapes:

   a. Base for Portland Cement Mortar and thinset Mortar Installations: Coved.
   b. Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap.
   c. Wainscot Cap for Thinset Mortar Installations: Surface bullnose.
   d. External Corners for Portland Cement Mortar Installations: Bullnose shape with a radius of not less than 3/4-inch unless otherwise indicated.
   e. External Corners for Thinset Installations: Surface bullnose.

3. Colors: Colors shall be as indicated on the Drawings, or if not indicated, as selected by Architect from manufacturer's full line of standard colors, after Bid Date.

D. Special Metal Trim and Nosings (IF ANY): Provide equivalent to standard products as manufactured by Schluter Systems, L.P.; Plattsburgh, NY; Phone: (800) 472-4588; Fax: (800) 477-9783;
E-mail: info@schluter.com; Website: www.schluter.com.

2.4 STONE THRESHOLDS

A. General: Provide stone which is uniform in color and finish, fabricated to sizes and profiles indicated or required to provide transition between tile surfaces and adjoining finished floor surfaces.

B. Marble Thresholds: Provide marble thresholds complying with ASTM C 503 requirements for exterior use and abrasion resistance for uses subject to heavy foot traffic.

1. Match Architect's sample for color and finish, where not indicated.
2. Provide white, honed marble complying with MIA Group "A" requirements for soundness, where indicated to be white.
3. Size: 2-inches wide x 1-inch thick (nominal) with beveled exposed edges, unless otherwise indicated or required.

2.5 SETTING MATERIALS

A. Portland Cement Mortar Installation Materials: Provide materials to comply with ANSI A108.1 as required for installation method designated, unless otherwise indicated.

B. Latex-Portland Cement Mortar: Provide product complying with ANSI A118.4 and the following requirement for composition:

1. Latex additive (water emulsion) of type described below, serving as a replacement for part or all of gauging water, added at job site to prepackaged dry mortar mix supplied or specified by latex manufacturer.

a. Latex Type: Acrylic resin.

C. Organic Adhesive: Provide product complying with ANSI A136.1 for Type I.

2.6 GROUTING MATERIALS

A. Latex-Portland Cement Grout: Provide product complying with ANSI A118.6 for the following composition and of color indicated:

1. Latex additive (water emulsion) serving as a replacement for part or all of gauging water, added at job site to prepackaged dry grout mix, with type of latex and dry grout mix complying with requirements indicated below:

a. Latex Type: Acrylic resin.
b. Grout Type: Commercial portland cement grout specified or supplied by latex manufacturer.

B. Chemical Resistant Epoxy Grout: Provide product complying with ANSI A118.3 of color indicated.

1. Provide product with resistance to temperatures up to 300 degrees F (149 degrees C), certified by grout manufacturer for intended use.
2. Locations: All floor, base, and wall tile work within Toilet Rooms, at Janitor's Rooms, at rooms where food is stored, prepared and/or cooked, and at exterior tile work.

2.7 MISCELLANEOUS MATERIALS

A. Tile Cleaner: Product specifically acceptable to manufacturer of tile and grout manufacturer for application indicated and as recommended by National Tile Promotion Federation, 112 North Alfred Street, Alexandria, VA 22134 or Ceramic Tile Institute, 700 North Virgil Avenue, Los Angeles, CA 90029.

B. Waterproofing Membrane: Equivalent to "ECB Anti-Fracture Membrane" system or "Strataflex Waterproofing Membrane" factory prepared system, as manufactured by NAC Products, Inc.; Cuyahoga Falls, Ohio (Phone: 1-800-633-4622).

1. Provide complete system, including substrate primer/sealer, 40-mil, two component, self-adhering membrane, and appropriate top-coat primer for the material(s) to be placed over the ECB system.
2. Locations for Use: Below <u>all</u> tile flooring, turned up 1-inch at all edges and concealed by base material, and turned down at least 2-inches into floor drains.
3. Completed membrane system is intended for waterproofing, and to bridge substrate joints within the limitations stated in manufacturer's current written product data.

2.8 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers for accurately proportioning of materials, water or additive content, mixing equipment and mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

<u>PART 3 - EXECUTION</u>

3.1 EXAMINATION

A. Examine surfaces to receive tile work and conditions under which tile will be installed. Do not proceed with tile work until surfaces and conditions comply with requirements indicated in referenced tile installation standard.

1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing or cleaning compounds.
2. Verify that installation of all required grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

B. Do not proceed with installation until unsatisfactory conditions and incomplete work have been corrected.

3.2 INSTALLATION, GENERAL

A. ANSI Tile Installation Standard: Comply with applicable parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile."

B. TCA Installation Guidelines: TCA "Handbook for Ceramic Tile Installation"; comply with TCA installation methods indicated or, if not otherwise indicated, as applicable to installation conditions shown.

C. Extend tile work into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.

D. 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 that plates, collars, or covers overlap tile.

E. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise shown.

1. For tile mounted in sheets make joints between tile sheets same width as joints within tile sheets so that extent of each sheet is not apparent in finished work.

F. Expansion Joints: Locate expansion joints and other sealant filled joints, including control, contraction and isolation joints, where indicated, or if not indicated, at spacings and locations recommended in TCA "Handbook for Ceramic Tile Installation," and approved by Architect. Do not saw cut joints.

1. Sealing of joints is specified in Section 079000 - "Joint Sealants."
2. Provide expansion joints in tile and setting beds directly above all unsealed and unbridged expansion joints, control joints, construction joints, cold joints and saw-cut control joints in the building structure; and where tile work abuts restraining surfaces such as perimeter walls, dissimilar floors, curbs, columns, pipes, ceilings, and where changes occur in backing materials. Expansion joints shall be provided as follows:

   a. Floor Tile: Minimum 1/4-inch joint width; joints 36-feet o.c. maximum.

3. Joints in tile and setting materials directly over any unsealed and unbridged structural joints shall never be narrower than the width of the structural joint. Joints over saw-cut control joints shall never be less than the width of the saw-cut joint width. Preparation and installation shall be as required for expansion joints.
4. To insure that locations of any unsealed and unbridged joints in tile work align with existing joints in substrates, joints in tile work shall be constructed during installation of mortar beds and/or tile, rather than saw-cutting joints after installation.
5. Keep expansion joint cavities open and free of dirt, debris, grout, mortar and setting materials.
6. Set compressible back-up strip when mortar is placed or utilize removable wood strip to provide space for back-up after mortar has cured.
7. Install sealant after tile work and grout are dry.

G. Grout tile to comply with the requirements of the following installation standards:

1. For ceramic tile grouts (sand-portland cement, dry-set, commercial portland cement, and latex-portland cement grouts) comply with ANSI A108.10.
2. For chemical resistant epoxy grouts comply with ANSI A108.6.

3.3 FLOOR INSTALLATION METHODS

A. Ceramic Tile: Install tile to comply with requirements indicated below for setting bed methods, TCA installation methods related to types of subfloor construction, and grout types:

1. Portland Cement Mortar: ANSI A108.1.
2. Bond Coat: Portland cement paste on plastic bed or the following thin-set mortar on cured bed or concrete slabs, ANSI A108.5, at Contractors option:

    a. Latex-portland cement mortar.

3. Concrete Subfloors, Interior: TCA F112 (bonded).
4. Concrete Subfloors, Interior: TCA F114 (with chemical resistant epoxy grout).
5. Grout:

    a. Latex-portland cement (interior).
    b. Chemical Resistant Epoxy: ANSI 108.6.

B. Stone Thresholds: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile unless otherwise indicated.

1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent non-tile floor finish.

3.4 WALL TILE AND TRIM INSTALLATION METHODS

A. Install types of tile designated for wall application to comply with requirements indicated below for setting bed methods, TCA installation methods related to subsurface wall conditions, and grout types:

1. Portland Cement Mortar: ANSI A108.1.

    a. Masonry or Concrete, Interior: TCA W211 (bonded).
    b. Grout: Sand-portland cement (ANSI 108.10), except chemical resistant epoxy (ANSI 118.3) at toilet rooms.
    c. Location: At locations indicated on Drawings, or if not applicable, at conditions required by project conditions.

2. Organic Adhesive: ANSI A108.4.

    a. Solid Backing, Interior: TCA W223.
    b. Grout: Latex-portland cement, (ANSI 108.10), except chemical resistant epoxy (ANSI 118.3) at toilet rooms.

3.5 CLEANING AND PROTECTION - TILE WORK

A. Cleaning: Upon completion of placement and grouting, clean all new tile surfaces so they are free of foreign matter.

1. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14-days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.
2. Clean stone in accordance with manufacturer's / fabricator's current written instructions and recommendations. Apply clear, non-yellowing, slip resistant sealer recommended in writing by manufacturer / fabricator of stone and by manufacturer of slip-resistant sealer - to all stone.

B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.

C. Protection: When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage and wear.

1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with draft paper or other heavy covering during construction period to prevent staining, damage, and wear.
2. Prohibit foot and wheel traffic from using tiled floors for at least 7-days after grouting is completed.
3. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF 093013

SECTION 095113 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

B. Related work specified elsewhere includes:

1. Section 079000 - “Joint Sealers” (acoustical and joint sealant)
2. Division 26- (Electrical items, light fixtures, etc., mounted in ceilings).

1.2 SUMMARY:

A. This Section includes acoustical and non-acoustical panel ceilings installed with exposed grid suspension systems.

1. Type 1 (ACT-1): Square edge acoustical panel system in Standard Finish Grid (Acoustical panels), at locations indicated on the Drawings.

1.3 SUBMITTALS:

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of product specified.
2. Samples for verification purposes of each type of exposed finish required, prepared on samples of size indicated below and of same thickness and material indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

a. 6-inch-square samples of each acoustical panel type, pattern, and color.
b. Set of 12-inch-long samples of exposed suspension system members, including moldings, for each color and system type required.

1.4 QUALITY ASSURANCE:

A. Installer Qualifications: Engage an experienced Installer who has successfully completed acoustical ceilings similar in material, design, and extent to those indicated for Project, and which is acceptable to manufacturer of acoustical products herein, as indicated by written statement by their manufacturer(s).

B. Fire-Performance Characteristics: Provide acoustical ceilings that are identical to those tested for the following fire-performance characteristics, per ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.

   a. Flame Spread: 25 or less.
   b. Smoke Developed: 50 or less.

C. Acoustical Performance Characteristics: Provide acoustical ceiling systems which have been tested by UL or other acceptable independent testing organization, to certify compliance with STC and CAC minimum requirements indicated herein.

D. Single-Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling unit from a preapproved manufacturer and a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

E. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, and wall and partition systems.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

D. Refer to Division 1 Sections “Product Requirements” for additional information and requirements regarding stored materials.

1.6 PROJECT CONDITIONS:

A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.7 EXTRA MATERIAL:

A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with appropriate labels.

   1. Acoustical Units: Furnish one box of full-size units, in whole unused cartons.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CEILING UNITS, GENERAL:

A. Standard for Acoustical Ceiling Units: Provide manufacturer's standard units of configuration indicated that comply with ASTM E 1264 classifications as designated by reference to types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400 (plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from the test surface) per ASTM E 795.

B. Colors and Patterns: Provide products to match appearance characteristics indicated under each product type, or if not indicated, as selected by COR from manufacturer's standard colors, surface textures, and patterns available for ceiling panels and exposed metal suspension systems of quality indicated herein.

2.2 ACOUSTICAL UNITS:

A. Type 1 (ACT-1): Manufacturer's standard lay-in non-directional random pattern, lightly fissured, heavily perforated panels, and as follows, unless indicated otherwise:

1. Size: 24 inches x 24 inches x 5/8 inch.
2. Edge: Square.
3. NRC Range: 0.55.
4. CAC Range: 35.
5. Color: White.
6. Light Reflectance: 0.86
7. Manufacturer/Product - Provide one of the following; Class A flame spread:

a. Armstrong World Industries, Inc., "School Zone, Fine Fissured", No. 1713, with standard "Humigard Plus" humidity resistance and "Bio-Block" mold/mildew resistant paint and treatment; with Prelude XL 7300 Series grid.
b. CertainTeed "Fine Fissured High NRC", No. HHF-457 HNRC, with standard humidity resistance and mold/mildew resistant paint and treatment; with CertanTeed Classic Stab Series grid.
c. USG Interiors, Inc., "Astro Climaplus,", No., 8221, with standard humidity resistance and mold/mildew resistant paint and treatment; with USG DX/DXL Series grid.

8. Grid: Standard hot-dipped galvanized steel in white color to match ceiling tile; 15/16-inch exposed tee grid.

2.3 METAL SUSPENSION SYSTEMS, GENERAL:

A. Standard for Metal Suspension Systems: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.

B. Finishes and Colors: Provide manufacturer's standard factory-applied finish for type of system indicated, unless otherwise required.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

    a. Product/Manufacturer: Galvanized, aluminum capped grid.

        1) "Environmental ZXLA Grid System," as manufactured by USG Interiors or Donn.
        2) "Prelude Plus" Environmental Tee System, as manufactured by Armstrong World Industries, Inc.
        3) "Protectone" Series, as manufactured by CertainTeed.

C. Attachment Devices: Size for 5 times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

D. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched.

1. Gauge: Provide wire sized to that stress at 3 times hanger design load (ASTM C 635, Table 1, Direct-Hung), will be less than yield stress of wire, but provide not less than 0.106-inch diameter (12 gauge).

E. Hanger Rods - (as required): Mild steel, zinc coated, or protected with rust-inhibitive paint.

F. Angle Hangers - (as required): Angles with legs not less than 7/8 inch wide, formed with 0.0365-inch-thick galvanized steel sheet complying with ASTM A 446, Coating Designation G90, with bolted connections and 5/16-inch-diameter bolts.

G. Edge Moldings and Trim: Metal or extruded aluminum of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit type of edge detail and suspension system indicated.

H. Subject to compliance with requirements, provide suspension systems of one of the following:

1. Manufacturers of Steel Exposed Suspension Systems:

    a. Same as ceiling panel unit manufacturer.
    b. Armstrong World Industries, Inc.
    c. CertainTeed.
    d. Chicago Metallic Corporation.
    e. Donn Corporation.

2. Manufacturers of Moldings and Trim:

    a. Construction Specialties.
    b. Fry Reglet Corporation.
    c. Gordon, Inc.
    d. MM Systems.
    e. Technical Ceiling Systems, Inc.
    f. Same as Suspension system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling and panel systems. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION:

A. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors, or supports, whose installation is specified in other sections.

1. Furnish galvanized inserts and similar devices as required for wood structure (if required), to other trades for installation well in advance of time needed for coordination of other work.

B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION:

A. General: Install acoustical ceiling and panel systems to comply with installation standard referenced below, per manufacturer's current written instructions and CISCA "Ceiling Systems Handbook."

1. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C 636.

B. Arrange acoustical units and orient directionally patterned units, (if any) in a manner shown by reflected ceiling plans.

1. Install panels with pattern running in one direction, as indicated, or if not indicated, as requested from and directed by Architect.

C. Suspend ceiling hangers from building structural members and as follows, with system leveling tolerance of 1/8 inch in 12'-0":

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

4. Secure cable, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices that are secure and appropriate for structure to which cables and hangers are attached as well as for type of cable, hanger and hardware involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
5. Space ceiling panel hangers not more than 4'-0" o.c. along each member supported directly from hangers, unless otherwise shown, and provide hangers not more than 8 inches from ends of each member.

    a. Provide additional hangers as necessary, so that one hanger occurs on each side of lay-in and surface-mounted light fixtures, and at other grid supported equipment, devices, etc.

6. Install “high humidity finish” systems at all areas indicated to receive lay-in vinyl-faced gypsum “non-acoustical” ceiling panels.
7. Install cable hangers with all indicated and otherwise necessary hardware for complete and proper installation of ceiling and panel systems.

D. Install edge moldings of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical units.

1. Screw-attach moldings to substrate at intervals not over 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12'-0". Miter corners accurately and connect securely.

3.4 CLEANING:

A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer’s instructions for cleaning and touch-up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF 095113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. This Section includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces, except where noted otherwise.

1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

B. Paint exposed surfaces whether or not colors are designated in “schedules,” except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.

1. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
2. Pipe identification tags end markers or bands, direction of flow arrows, voltage identification, etc., if any, are provided under Division 22- “Mechanical”, and Division 26 - “Electrical.”

C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.

1. Examples of prefinished items not to be painted include, in part, the following factory-finished components:

a. Metal and plastic laminate toilet enclosures and partitions.
b. Acoustic materials.
c. Plastic laminate casework.
d. Finished mechanical and electrical equipment.
e. Light fixtures.
f. Switchgear.
g. Distribution cabinets.
h. Signage, Plaques, Directories, and Bulletin Boards.
i. Storefront.
j. Finish Hardware.

2. Examples of concealed surfaces not to be painted include, in part, wall or ceiling surfaces in the following generally inaccessible areas:

a. Foundation spaces.
b. Furred areas.

c. Utility tunnels.
d. Pipe spaces or chases.
e. Duct shafts.

3. Examples of Finished metal surfaces not to be painted include, in part, the following:

a. Anodized aluminum.
b. Stainless steel.
c. Chromium plate.
d. Copper.
e. Bronze.
f. Brass.
g. Prefinished aluminum windows and trim.

4. Examples of operating parts not to be painted include, in part, moving parts of operating equipment such as the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Where walls are indicated or otherwise required to be fire-rated and/or smokestop partitions, and at all corridor partitions, exit enclosures, and fire walls, they shall be effectively and permanently identified with signs or stenciling in a manner acceptable to the authority having jurisdiction. Such identification shall be above any decorative ceiling and in concealed spaces. Suggested wording, "Fire and Smoke Barrier - Protect All Openings":

1. Minimum size of lettering to be 1-1/2" high.
2. Minimum of one sign or stencil at each side of each such wall.
3. Maximum spacing of signs or stenciling at each side of continuous walls to be 20'-0" on center.

1.3 SUBMITTALS:

A. Product Data: Manufacturer's most current technical information, label analysis, and application instructions for each material proposed for use.

1. List each material and cross-reference to scheduled paint types, and including each specific coating, finish system, and application. Identify each material by the manufacturer's catalog number and general classification.

B. Samples for initial color selection in the form of manufacturer's color charts from paint manufacturer intended for use.

C. Samples for verification purposes: Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate. Define each separate coat, including fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.

1. Submit samples on the following substrates for the Architect's review of color and texture only: Stained or Natural Wood: Provide two 4- by 8-inch samples of natural and stained wood finish on actual wood surfaces.

1.4 QUALITY ASSURANCE:

A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by paint manufacturer, and use only within the recommended limits.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Architect of any problems anticipated using the materials specified, prior to proceeding with work.

C. Material Quality: Provide the manufacturer's best quality grade paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude approved equivalent products of other manufacturers.

D. Color Pigments: Pure, non-fading, applicable types to suite substrates and service indicated.

E. Lead content in pigments or other painting materials and components is not allowed.

F. Solvents and V.O.C. Compliance: At the time of this writing, sufficient product data and information is not available from paint manufacturers to specify new products to replace solvent based products specified. If new regulations are in effect restricting use of solvents and/or they are not available at the time painting is required for this project, submit and provide the equivalent water-borne products to those specified, at no additional cost to the Owner.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's name, stock number, and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.

B. Store materials not in use in tightly covered containers in a well- ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers, others present or passing through or inspecting work areas (painting or any other work), and the work areas themselves are protected from fire and health hazards resulting from handling, mixing, and application of materials.

1.6 JOB CONDITIONS:

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 deg F and 90 deg F, unless otherwise permitted by paint manufacturer's printed instructions.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 deg F and 95 deg F, unless otherwise permitted by paint manufacturer's printed instructions.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer, during application, drying and curing periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Benjamin Moore and Co. (Moore).
2. PPG Industries, Pittsburgh Paints (Pittsburgh).
3. The Sherwin-Williams Company (S-W). *Basis of Design
4. TNEMEC Company, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION:

A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.

1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

B. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.
2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

    a. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.
    b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.

3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

    a. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer before application of primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Fill cracks in wood or plywood floors with a latex filler and prime filled areas after sanding, except where otherwise recommended by paint manufacturer. Sand smooth when dried.
    b. Prime, stain, or seal unfinished wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.
    c. When transparent finish is required, backprime with spar varnish.
    d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
    e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately upon delivery.

4. Ferrous Metals: Clean nongalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.

    a. Treat bare, sandblasted, or pickled clean metal with a metal treatment wash coat before priming.
    b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

5. Galvanized Surfaces: Clean galvanized surfaces with non- petroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

C. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.

1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

D. Tinting: Tint each primer and undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat(s), but provide sufficient differences in shade of undercoats to distinguish each separate coat.

1. Finish coats as scheduled, shall be same color for each coat required.

3.3 APPLICATION:

A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied. Use of spray equipment at the site is not allowed, except where specifically indicated.

1. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
2. Paint surface treatments and finishes are indicated on the Drawings and in Specifications.
3. Finish colors will be selected after Bidding, unless indicated otherwise.
4. Provide finish coats that are compatible with primers used.
5. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.
6. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
7. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, connector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.
8. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
9. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
10. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

B. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.

C. Finish doors on tops, bottoms, and side edges same as faces.

1. Sand lightly between each succeeding enamel or varnish coat.

D. Primers:

1. Omit primer on metal surfaces that have been shop-primed and touch-up painted, only after verifying full compatibility of shop primers with materials specified for the next coat and finish coats.
2. Primer may be omitted at previously painted existing surfaces in good condition, except at interior concrete, plaster and drywall surfaces, after repairs to any existing damaged substrates and after spot priming of existing damaged paint finish, followed by cleaning and preparation recommended in writing by paint manufacturer.

E. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

F. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.

G. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces.

1. Mechanical items to be painted include but are not limited to:

a. Piping, pipe hangers, and supports.
b. Tanks.
c. Ductwork.
d. Insulation.
e. Supports.
f. Accessory items.

2. Electrical items to be painted include but are not limited to:

a. Conduit and fittings.
b. Switchgear.

H. Block Fillers: Apply block fillers to new or previously unpainted concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before application of finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.4 CLEANING:

A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION:

A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.

B. Provide “wet paint” signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINT SCHEDULE:

A. General: Provide the following paint systems for the various substrates, as indicated.

P-7: <u>IRON AND STEEL SURFACES</u>:

1. Sherwin-Williams:
   a. Primer (1ct): Pro Industrial Pro-Cryl Universal Primer, B66-310
   b. Finish (2cts): Pro Industrial Acrylic Coating, B66-600 Series
      (Gloss, B66-600 Series / Semi-Gloss, B66-650 Series)
      Gloss Finish (Solvent Base)
      1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series
      (2-4 mils dry)
      2nd Coat: S-W Industrial Enamel, B54 Series
      3rd Coat: S-W Industrial Enamel, B54 Series
      (2.0 - 4.0 mils dry per coat)

2. <u>NOTE</u>: Provide equivalent “dry-fall” product spray-applied finish coats over primer for any <u>steel structure and exposed steel decking</u> which will remain exposed after other work and improvements; 2 Coats.

   Sherwin-Williams:

a. Primer (1ct): Pro Industrial Pro-Cryl Universal Primer, B66-310
b. Finish (2cts): Low VOC Waterbased Dry Fall,
(Flat, B42W81 – EggShell, B42W82 – S/G, B42W83)

COMPLETELY COVER AND PROTECT ENTIRE FLOOR IN ROOMS WHERE OCCURS, PRIOR TO APPLICATIONS.

P-8: GALVANIZED STEEL AND ALUMINUM SURFACES:

1. Sherwin-Williams:
a. Primer (1ct): Pro Industrial Pro-Cryl Universal Primer, B66-310
b. Finish (2cts): Pro Industrial Acrylic Coating, B66-600 Series
(Gloss, B66-600 Series / Semi-Gloss, B66-650 Series)
Gloss Finish (Solvent Base)
1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series
(2-4 mils dry)
2nd Coat: S-W Industrial Enamel, B54 Series
3rd Coat: S-W Industrial Enamel, B54 Series
(2.0 - 4.0 mils dry per coat)

P-9: CONCRETE SURFACES:

1. Sherwin-Williams:
a. Primer (1ct): Loxon Concrete & Masonry Primer, A24W8300
b. Finish (2cts): ProMar 200 Zero VOC Interior Latex Egg-Shell, B20-2600
c. Option:
Finish (2cts): Harmony Interior Latex Eg-Shel, B09-1000 Series
(product is Zero VOC, Tints with Zero VOC Tint, Anti-Microbial, Odor reducing and has VOC Eliminating technology – NO Other products offers the same features)

P-10: WOOD SURFACES TO BE PAINTED (OPAQUE FINISH):

1. Sherwin-Williams:
a. Primer (1ct): Premium Wall & Wood Primer, B28W8111
b. Finish (2cts): ProMar 200 Zero VOC Interior Latex S/G, B31-2600;

P-11: DRYWALL SURFACES - (Dry Areas):

1. Sherwin-Williams:
a. Primer (1ct): HB Interior Latex Primer/Surfacer, B28W08601;

Coverage: can be applied from: 400 sq ft/gal @ 4 mils wet; 0.8 mils dry to: 80 sq ft/gal @ 20 mils wet; 4.4 mils dry

Number of coats as required to conceal minor wall irregularities, imperfections, differing textures, joint taping and mudding, etc., prior to finish coats.

b. Finish (2cts): ProMar 200 Zero VOC Interior Latex Egg-Shell, B20-2600
c. Option:
Finish (2cts): Harmony Interior Latex Eg-Shel, B09-1000 Series

(product is Zero VOC, Tints with Zero VOC Tint, Anti-Microbial, Odor reducing and has VOC Eliminating technology – NO Other products offers the same features)

P-12: DRYWALL SURFACES - (Wet Areas: Toilet, Locker, Shower & Janitors Rooms, Kitchen Areas, any room with a plumbing fixture, and areas where food is stored, prepared, cooked and/or served):

1. Sherwin-Williams:
   a. Primer (1ct): HB Interior Latex Primer/Surfacer, B28W08601; Approximately 20-mil dry thickness; This primer only, spray-applied. Number of coats as required to conceal minor wall irregularities, imperfections, differing textures, joint taping and mudding, etc., prior to Second Primer and finish coats.
   b. Finish (3cts): Waterbased Catalyzed Epoxy, B70W211 (Semi-Gloss, B60V25 – Gloss, B60V15)

P-13: CMU AND BRICK SURFACES - (Dry Areas):

1. Sherwin-Williams:
   a. Primer (1ct): PrepRite Interior / Exterior Block Filler, B25W25;
   b. Finish (2cts): ProMar 200 Zero VOC Interior Latex S/G, B31-2600;
   c. All block pores shall be completely filled.

P-14: CMU AND BRICK SURFACES - (Wet Areas: Toilet, Locker, Shower & Janitors Rooms, Kitchen Areas, any room with a plumbing fixture, and areas where food is stored, prepared, cooked and/or served):

1. Sherwin-Williams
   a. Primer (1ct): Heavy Duty Block Filler, B42W46; Option: Cement-Plex 875 Epoxy Block Filler, B42W200.
   b. Finish (2cts): Pro Industrial Waterbased Catalyzed Epoxy, B73-300 Series.
   c. All block pores shall be completely filled.

END OF 099123

SECTION 102113 - TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Solid Phenolic, Moisture Resistant Substrate: (Bobrick DuraLineSeries®)
   1. Toilet Partitions:
      a. Configuration: Floor-Anchored, Overhead-Braced.
   2. Urinal Privacy Screens:
      a. Configuration: Wall-Hung.

1.2 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry, coordination with blocking in walls to secure panels, wall posts and stiles.

B. Section 092000 - Gypsum Board, coordination with blocking.

C. Section 093000 - Tiling, coordination with layout and installation.

D. Section 102800 - Washroom Accessories, for accessories.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets for each product specified.

B. Shop Drawings: Submit manufacturer’s shop drawings for each product specified, including the following:
   1. Plans, elevations, details of construction and attachment to adjacent construction.
   2. Show anchorage locations and accessory items.
   3. Verify dimensions with field measurements prior to final production of toilet compartments.

1.4 QUALITY ASSURANCE

A. Manufacturer: Provide products manufactured by a company with a minimum of 10 years successful experience manufacturing similar products.

B. Single Source Requirements: To the greatest extent possible provide products from a single manufacturer.

C. Accessibility Requirements: Comply with requirements applicable in the jurisdiction of the project, including but not limited to ADA and ICC/ANSI A117.1 requirements as applicable.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations. Protect from damage.

1.6 WARRANTY

A. Manufacturer's Warranty (DuraLineSeries): Manufacturer's standard 15 year limited warranty for panels, doors, and stiles against breakage, corrosion, delamination, and defects in factory workmanship. Manufacturer's standard 1 year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design Products: Based on the quality and performance requirements of the project, specifications are based solely on the products of Bobrick Washroom Equipment, Inc.. www.bobrick.com. Location of manufacturing shall be the United States.

B. Substitutions: The Architect will consider products of comparable manufacturers as a substitution, pending the contractor's submission of adequate documentation of the substitution in accordance with procedures in Division 1 of the Project Manual. Documentation shall include a list of five similar projects of equivalent size where products have been installed for a minimum of two years, and manufacturer's certification that products are fabricated in the United States.

2.2 SOLID PHENOLIC, MOISTURE RESISTANT SUBSTRATE (DuraLineSeries)

A. Solid Phenolic, Moisture Resistant Partitions: Bobrick DuraLineSeries.
   1. Color: As selected by COR from manufacturer's standard DuraLineSeries range.

B. Toilet Partitions:
   1. Configuration: Floor-Anchored, Overhead-Braced partitions; satin finish; extruded anodized aluminum headrails with satin finish, 0.065 inch (1.65 mm) thick with anti-grip profile.
      a. Basis-of-Design: Bobrick 1182 DuraLineSeries Toilet Partitions.
         1) Design: Standard design.
         2) Hardware: Standard hardware.

   2. Fire Resistance:
      a. Flame Spread Index (ASTM E 84): 15 for panels, doors and stiles.
      b. Smoke Developed Index (ASTM E 84): 25 for panels, 20 for doors and stiles.
      c. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class A.
      d. Uniform Building Code: Class I.

C. Urinal Privacy Screens:
   1. Basis-of-Design: Bobrick 1185 DuraLineSeries Wall-Hung Urinal Privacy Screens.
   2. Hardware: To match partition hardware.
   3. Fire Resistance:
      a. Flame Spread Index (ASTM E 84): 15 for panels and stiles.
      b. Smoke Developed Index (ASTM E 84): 25 for panels, 20 for stiles.
      c. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class A.
      d. Uniform Building Code: Class I.

D. Materials: Solid phenolic material for stiles, panels, doors and screens.
   1. Phenolic Construction: Solidly fused high pressure laminate with matte-finish melamine surfaces; integrally bonded colored face sheets and black phenolic-resin core.
   2. Phenolic Edges: Black; brown edges not acceptable.

E. Finished Thickness:
   1. Stiles and Doors: 3/4 inch.
      a. Finished thickness of doors and stiles to ensure flush front.
   2. Panels and Screens: 1/2 inch.

F. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge (1.6 mm) stainless steel with satin finish; 1 inch x 1-1/2 inches x 58 inches high .

G. Stiles: Floor-Anchored stiles furnished with expansion shields and threaded rods.
   1. Leveling Devices: 7 gauge, 3/16 inches thick, corrosion-resistant, chromate-treated, double zinc-plated steel angle leveling bar bolted to stile; furnished with 3/8 inch diameter threaded rods, hex nuts, lock washers, flat washers, spacer sleeves, expansion anchors, and shoe retainers.
   2. Stile Shoes: One-piece, 22 gauge, 18-8, Type 304 stainless steel, 4 inch height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch or 1 inch stile thickness and capable of being fastened (by clip) to stiles starting at wall line.

H. Anchors: Expansion shields and threaded rods at floor connections as applicable.

I. Hardware:
   1. Compliance: Operable with one hand, without tight grasping, pinching, or twisting of the wrist, and force to operate does not exceed five pounds.
   2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment.
   3. Materials: 18-8, Type 304, heavy-gauge stainless steel with satin finish. Chrome-plated “Zamak”, aluminum, or extruded plastic hardware not acceptable.
   4. Fastening: Hardware secured to door and stile by through-bolted, theft-resistant, pin-in-head Torx stainless steel machine screws into factory-installed, threaded brass inserts. Fasteners secured directly into core not acceptable.
      a. Threaded Brass Inserts: Factory-installed; withstand direct pull force exceeding 1500 lb per insert.
   5. Clothes Hooks: Projecting no more than 1-1/8 inch from face of door.
   6. Mounting: Hinges, keepers, latches, clothes hooks and their fasteners concealed inside compartment. Exposed hinges, keepers, latches, clothes hooks and their fasteners on exterior of compartment not acceptable with the exception of accessible compartments.
   7. Hardware Type: Standard, commercial hardware.
      a. Latching: Track of door latch prevents inswing doors from swinging out beyond stile; on outswing doors, door keeper prevents door from swinging in beyond stile; 14 gauge (2 mm) sliding door latch, 11 gauge (3.2 mm) keeper. Black rubber bumper on latch serves as door bumper for inswing door. Twist-style door latch operation not acceptable.
      b. Hinges: Balanced, with field-adjustable cam to permit door to be fully closed or partially open when compartment is unoccupied.

c. Locking: Door locked from inside by sliding door latch into keeper.
d. Mounting Brackets: Mounted inside compartment; exposed brackets on exterior of compartment not acceptable with the exception of outswing doors.

8. Hardware Type: Institutional hardware (.67).
   a. Latching: 14 gauge sliding door latch, 11 gauge keeper; latch slides on shock-resistant nylon track. Twist-style door latch operation not acceptable.
   b. Hinges: 16 gauge stainless steel with satin finish, self-closing, 3 section hinges.
   c. Mounting Brackets: 18 gauge stainless steel and extend full height of panel.
      1) U-Channels: Secure panels to stiles.
      2) Angle Brackets: Secure stiles-to-walls and panels-to-walls.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare substrates including but not limited to blocking and supports in walls at points of attachment using methods recommended by the manufacturer for achieving the best result for the substrates under the project conditions.
   1. Inspect areas scheduled to receive compartments for correct dimensions, plumbness of walls, and soundness of surfaces that would affect installation of mounting brackets.
   2. Verify spacing of plumbing fixtures to assure compatibility with installation of compartments.

B. If preparation is the responsibility of another installer, notify COR in writing of deviations from manufacturer's recommended installation tolerances and conditions.

C. Do not proceed with installation until substrates have been properly prepared with blocking and supports in walls and ceilings at points of attachment and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.

3.2 INSTALLATION

A. Install products in strict compliance with manufacturer's written instructions and recommendations, including the following:
   1. Verify blocking and supports in walls and ceilings have been installed properly at points of attachment.
   2. Verify location does not interfere with door swings or use of fixtures.
   3. Use fasteners and anchors suitable for substrate and project conditions
   4. Install units rigid, straight, plumb, and level.
   5. Conceal evidence of drilling, cutting, and fitting to room finish.
   6. Test for proper operation.

3.3 ADJUSTING, CLEANING AND PROTECTION

A. Adjust hardware for proper operation after installation. Set hinge cam on in-swinging doors to hold doors open when unlatched. Set hinge cam on out-swinging doors to hold unlatched doors in closed position.

B. Touch-up, repair or replace damaged products.

C. Clean exposed surfaces of compartments, hardware, and fittings.

END OF SECTION 102113

SECTION 102800 - WASHROOM ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Washroom Accessories:
1. Soap dispensers.
2. Paper towel dispensers.
3. Mirrors.
4. Grab bars.

1.2 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry, coordination with blocking.

B. Section 092000 - Gypsum Board, coordination with blocking.

C. Section 093000 - Tiling, coordination with layout and installation.

D. Section 102113 - Toilet Compartments, coordination with accessories.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets for each product specified, including the following:
1. Installation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Cleaning and maintenance instructions.
4. Replacement parts information.

B. Schedule: Submit a toilet accessory schedule, indicating the type and quantity to be installed in each washroom. Use room numbers as indicated on the Drawings.

1.4 QUALITY ASSURANCE

A. Manufacturer: Provide products manufactured by a company with a minimum of 10 years successful experience manufacturing similar products.

B. Single Source Requirements: To the greatest extent possible provide products from a single manufacturer.

C. Accessibility Requirements: Comply with requirements applicable in the jurisdiction of the project, including but not limited to ADA and ICC/ANSI A117.1 requirements as applicable.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations. Protect from damage.

1.6 WARRANTY

A. Manufacturer’s Warranty for Washroom Accessories: Manufacturer’s standard 1 year warranty for materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Basis of Design: Bobrick Washroom Equipment, Inc., www.bobrick.com.
1. Location of Manufacturer: United States.
2. Equal products of other manufacturers may be used.

2.2 SOAP DISPENSERS

A. Surface-Mounted Horizontal Soap Dispensers:
1. Basis of Design: Bobrick Classic Model B-2112.
2. Compliance: Valve is operable with one hand, without tight grasping, pinching or twisting of the wrist and with less than 5 pounds of force to comply with barrier-free accessibility guidelines, including ADA-ABA and ICC/ANSI.
3. Container:
a. Materials: 18-8 S, Type 304, 22 gauge stainless steel with satin finish.
b. Construction: Body is drawn, one-piece, seamless construction.
4. Valve: Corrosion-resistant, black molded plastic push button and spout, antibacterial-soap-resistant plastic cylinder; soap head-holding mushroom valve, stainless steel spring, U-packing seal and duckbill. Valve dispenses commercially marketed all-purpose hand soaps.
5. Mounting: Vandal-resistant, concealed wall plate; back plate with mounting bracket.
6. Filling: Locked, hinged stainless steel lid for top filling opens with key provided. To prevent corrosion of tank, use only chloride-free pH-neutral liquid soaps.
7. Refill Indication: Clear acrylic refill-indicator window.
8. Capacity: 40 fl oz.

2.3 PAPER TOWEL DISPENSERS

A. Surface-Mounted Roll-Paper-Towel Dispensers:
1. Basis of Design: Bobrick Model B-2860.
2. Cabinet: All-welded, 18-8 S, Type 304, 22 gauge stainless steel with satin finish on exposed surfaces; inside equipped with 90 degree return towel guide bracket to prevent paper towels from falling forward out when door is opened.
3. Cabinet Back: With recessed mounting slots to prevent screws from snagging towels.
4. Door: Drawn, one-piece, seamless, 18-8 S, Type 304, 22 gauge stainless steel with satin finish; with tumbler lock keyed like other washroom accessories.
5. Hinge: Full-length stainless steel piano-hinge.
6. Towel Dispensing: Formed towel tray opening dispenses towels without tearing.
7. Filling: After unlocking with key provided, door swings down for loading towels.
8. Refill Indication: Two slots on each side of cabinet indicate refill time.
9. Capacity: 400 C-fold or 525 multifold towels 2-1/2 inches to 3-1/8 inches deep.

2.4 MIRRORS

A. Stainless Steel Channel Frame Mirrors:
1. Basis of Design: Bobrick Model B-165 2436.
a. Overall Size: 24 inches W x 36 inches H.
b. Configuration: Snap locking design.
2. Channel Frame: One-piece, Type 430 stainless steel channel-frame, 1/2 inch x 1/2 inch x 3/8 inch, with 90 degree mitered corners; bright polished finish on exposed surfaces.
3. Mirror: No. 1 quality, 1/4 inch float glass, guaranteed for 15 years against silver spoilage.

a. Corners: Protected by friction-absorbing filler strips.
b. Back of Mirror: Protected by full-size, shock absorbing, water-resistant, nonabrasive, 3/16 inch thick polyethylene padding.

4. Mounting: Removable; galvanized steel back with integral horizontal hanging brackets located at top and bottom for mounting on concealed rectangular wall hanger; locking devices secure mirror to concealed wall hanger.
5. Wall Hanger: Concealed, 20 gauge galvanized steel; incorporates lower support member to engage lower backplate louvers to keep bottom of mirror against wall.

2.5 GRAB BARS

A. Stainless Steel Grab Bars: With snap flange covers:
1. Satin Finish with Peened Grip:
a. Basis of Design: Bobrick Model B-6806.99X18
1) Length: 18 inches.
b. Basis of Design: Bobrick Model B-6806.99X36.
1) Length: 36 inches.
c. Basis of Design: Bobrick Model B-6806.99X42.
1) Length: 42 inches.
2. Compliance: Barrier-free accessibility guidelines (including ADAAG) for structural strength.
a. Capacity: Designed to support 900 lbs in compliant installations.
3. Description: Clearance between grab bar and finished wall is 1-1/2 inches.
4. Grab Bar Materials: 18-8 S, Type 304, stainless steel tubing with satin finish.
5. Grab Bar Construction: 18 gauge, ends heliarc welded to flanges.
6. Outside Diameter: 1-1/2 inch.
7. Mounting Flanges: Concealed, 18-8 S, Type 304, 1/8 inch thick, stainless steel plate.
a. End Flanges: 2 inches x 3-1/8 inches with two holes for attachment to wall.
b. Intermediate Flanges: 2-5/8 inches x 3-1/8 inches wide x 3-1/8 inch diameter.
8. Snap Flange Covers: 18-8 S, Type 304, 22 gauge drawn stainless steel with satin finish, 3-1/4 inch diameter x 1/2 inches deep; snap over mounting flange to conceal mounting screws.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in strict compliance with manufacturer's written instructions and recommendations, including the following:
1. Verify blocking has been installed properly.
2. Verify location does not interfere with door swings or use of fixtures.
3. Comply with manufacturer's recommendations for backing and proper support.
4. Use fasteners and anchors suitable for substrate and project conditions
5. Install units rigid, straight, plumb, and level, in accordance with manufacturer's installation instructions and approved shop drawings.
6. Conceal evidence of drilling, cutting, and fitting to room finish.
7. Test for proper operation.

3.2 CLEANING AND PROTECTION

A. Clean exposed surfaces of compartments, hardware, and fittings.

B. Touch-up, repair or replace damaged products until Substantial Completion.

END OF SECTION - 102800

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

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.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE 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. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL 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. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079000 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 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.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves.

2. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.

3. Interior Partitions:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

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. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
i. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

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. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Trerice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Ashcroft Inc.
   b. Marsh Bellofram.
   c. Miljoco Corporation.
   d. Palmer Wahl Instrumentation Group.

e. REOTEMP Instrument Corporation.
f. Trerice, H. O. Co.
g. Weiss Instruments, Inc.

3. Standard: ASME B40.200.
4. Case: Sealed type, cast aluminum or drawn steel; nominal diameter.
5. Element: Bourdon tube or other type of pressure element.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of scale range.

B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Ashcroft Inc.
    b. Miljoco Corporation.
    c. REOTEMP Instrument Corporation.

3. Standard: ASME B40.200.
4. Case: Sealed type, plastic; 4-1/2-inch nominal diameter.
5. Element: Bourdon tube or other type of pressure element.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Trerice, H. O. Co.

3. Standard: ASME B40.200.
4. Case: Cast aluminum; 6-inch nominal size.
5. Case Form: Back angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue or red organic liquid.
7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
8. Window: Glass or plastic.
9. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: 3/4 inch, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Flo Fab Inc.
    b. Miljoco Corporation.
    c. Palmer Wahl Instrumentation Group.
    d. Tel-Tru Manufacturing Company.
    e. Trerice, H. O. Co.
    f. Weiss Instruments, Inc.
    g. Winters Instruments - U.S.

3. Standard: ASME B40.200.
4. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
5. Case Form: Adjustable angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue or red organic liquid.
7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
8. Window: Glass.
9. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    m. Weiss Instruments, Inc.
    n. WIKA Instrument Corporation - USA.
    o. Winters Instruments - U.S.

3. Standard: ASME B40.100.

4. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
6. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Glass.
11. Ring: Metal.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    m. Weiss Instruments, Inc.
    n. WIKA Instrument Corporation - USA.
    o. Winters Instruments - U.S.

3. Standard: ASME B40.100.
4. Case: Liquid-filled type; cast aluminum or drawn steel; 6-inch nominal diameter with front flange and holes for panel mounting.
5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
6. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Glass.
11. Ring: Metal.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

C. Description: Test-station fitting made for insertion into piping tee fitting.

D. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

E. Thread Size: NPS 1/4 or, ASME B1.20.1 pipe thread.

F. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

G. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

8. Weiss Instruments, Inc.

C. Furnish one test-plug kit(s) containing one or two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

D. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

E. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

F. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

G. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Archon Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument.
4. Ernst Co., John C., Inc.
5. Ernst Flow Industries.
6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
7. OPW Engineered Systems; a Dover company.
8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

C. Description: Piping inline-installation device for visual verification of flow.

D. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

E. Minimum Pressure Rating: 125 psig.

F. Minimum Temperature Rating: 200 deg F.

G. End Connections for NPS 2 and Smaller: Threaded.

H. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

B. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

C. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

D. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

E. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

F. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

G. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

H. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled Solid-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled Open-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid-filled Open-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi and 0 to 600 kPa.

B. Scale Range for Water Service Piping: 0 to 160 psi and 0 to 1100 kPa.

C. Scale Range for Water Service Piping: 0 to 200 psi and 0 to 1400 kPa.

D. Scale Range for Domestic Water Piping: 0 to 100 psi and 0 to 600 kPa.

E. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

F. Scale Range for Domestic Water Piping: 0 to 200 psi and 0 to 1400 kPa.

G. Scale Range for Domestic Water Piping: 0 to 300 psi and 0 to 2500 kPa.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

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. Brass ball valves.
2. Bronze ball valves.
3. Bronze swing check valves.
4. Bronze globe valves.

B. Related Sections:

1. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handlever: For quarter-turn valves NPS 6 and smaller.
2. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inchstem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

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. Crane Co.; Crane Valve Group; Crane Valves.
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. NIBCO INC.

2. Description:

   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig
   c. CWP Rating: 600 psig
   d. Body Design: Two piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Brass.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.3 BRONZE BALL VALVES

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. Crane Co.; Crane Valve Group; Crane Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig

d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig
c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.5 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. NIBCO INC.
c. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

C. Class 150, Bronze Globe Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Kitz Corporation.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.6 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball and globe valves NPS 4and larger and more than 96 inchesabove floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.
2. Throttling Service: Globe valves.
3. Pump-Discharge Check Valves:

a. NPS 2and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Globe Valves: Class 150, bronze disc.

3.6 SANITARY-WASTE VALVE SCHEDULE

A. Pipe NPS 2and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Globe Valves: Class 150, bronze disc.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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 pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

1. Trapeze pipe hangers.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

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. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal, trapeze pipe hangers and attachments for general service applications.

F. Use and corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220719 - PLUMBING PIPING 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 insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.

e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    d. Mon-Eco Industries, Inc.; 22-25.

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
    d. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Phenolic Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

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 & F Wire.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
   d. Plumberex.
   e. Truebro; a brand of IPS Corporation.
   f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Truebro; a brand of IPS Corporation.
   b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.

c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

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. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.3 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Piping Specialties Products.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.; a Sensus company.
g. Viking Johnson.

2.4 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. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International.
   e. Matco-Norca.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig.
4. 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; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig.
5. 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. Calpico, Inc.
   c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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. Elster Perfection Corporation.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install shutoff valve immediately upstream of each dielectric fitting.

C. Install water-pressure-reducing valves downstream from shutoff valves.

D. Install domestic water piping level and plumb.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. 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.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

M. Install thermostats in hot-water circulation piping.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

E. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

A. Identify system components. Comply with MSFC requirements for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

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 it 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.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

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. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. ANACO-Husky.
   b. Fernco Inc.
   c. MIFAB, Inc.
   d. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, Hubless-Piping Couplings:

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. MG Piping Products Company.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Unions:
   1. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

      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) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.

      b. Standard: ASTM C 1173.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:

         1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

   3. Shielded, Nonpressure Transition Couplings:

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) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

4. Pressure Transition Couplings:

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) Cascade Waterworks Mfg. Co.
2) Dresser, Inc.
3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Smith-Blair, Inc.; a Sensus company.
7) The Ford Meter Box Company, Inc.
8) Viking Johnson.

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Carbon steel.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.

7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 150 psig.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca, Inc.
4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 150 psig 175 psig.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.
4) Precision Plumbing Products, Inc.
5) Victaulic Company.

b. Description:

1) Standard: IAPMO PS 66
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side

with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage.
2. Install drains in sanitary drainage gravity-flow piping.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for HVAC Piping."

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Copper DWV tube, copper drainage fittings, and soldered joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

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. Commercial, electric, storage, domestic-water heaters.
   2. Flow-control, electric, tankless, domestic-water heaters.
   3. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

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. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

   a. Commercial, Electric, Storage, Domestic-Water Heaters:

      1) Storage Tank: Three years.

   b. Electric, Tankless, Domestic-Water Heaters: Five year(s).

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Standard: UL 1453.
2. Storage-Tank Construction: Non-ASME-code, glass lined, steel vertical arrangement.

   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable extruded high density.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Jacket: Steel with baked enameled finish.

d. Heating Elements: Electric, bolt-on immersion type.
e. Temperature Control: Adjustable thermostat.
f. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
g. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 IN-LINE, SEALESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. Grundfos Pumps Corp.
4. TACO Incorporated.
5. WILO USA LLC - WILO Canada Inc.
6. Hyfab

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Single speed, unless otherwise indicated.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements below.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Install motors inclusive with equipment, provide high efficiency motors on pumps and fan motors.
4. Motors shall be selected for the duty they serve, motors will suit the ambient requirements.
5. Motor sizes and related equipment will be coordinated with electrical contractor prior to ordering.

2.4 CONTROLS

A. Pressure Switches: Electric, adjustable for control of water-supply pump.

1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, Type 4X.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V, ac.

B. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 50 to 125 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V, ac.
7. Settings: Start pump at 105 deg F and stop pump at 120 deg F.

C. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1.suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V, ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.

1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 250, Type 4X.
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: 120 V, ac.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

2.5 RESIDENTIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Capacity and Characteristics:

1. Capacity: 50 gal.
2. Recovery: 60 gal. at 80 deg F temperature rise.
3. Temperature Setting: 120 deg F.
4. Power Demand: 120 kilowatts.
5. Heating Elements: 6/6 kilowatts.

6. Electrical Characteristics:

    a. Volts: 480.
    b. Phases: Three.
    c. Hertz: 60.

2.6 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:

1. Chronomite Rheem Eemax.

2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
3. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

    a. Connections: ASME B1.20.1 pipe thread.
    b. Pressure Rating: 150 psig.
    c. Heating Element: Resistance heating system.
    d. Temperature Control: Flow-control fitting.
    e. Safety Control: High-temperature-limit cutoff device or system.
    f. Jacket: Aluminum or steel with enameled finish or plastic.
    g. Secure unit to all/or counter below sink.
4. Capacity and Characteristics:

    a. Flow Rate: 1.0 gpm.
    b. Maximum Temperature Setting: 140° F.
    c. Power Demand: 4.16 kilowatts.
    d. Electrical Characteristics:

        1) Volts: 208.
        2) Phases: Single.
        3) Hertz: 60.
        4) Full-Load Amperes: 20.

2.7 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
2. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics:

   a. Working-Pressure Rating: 150 psig.
   b. Capacity Acceptable: Acceptance valve minimum.
   c. Air Precharge Pressure:

B. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

C. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.

D. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

E. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

F. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

2.8 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be UL and IAPMO listed.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

   1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   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.

B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.

   1. Maintain manufacturer's recommended clearances.
   2. Arrange units so controls and devices that require servicing are accessible.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Anchor domestic-water heaters to substrate.

C. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains.

G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Fill electric, domestic-water heaters with water.

I. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with MSFC requirements for identification.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

END OF SECTION 223300

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

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. Water closets.
2. Flushometer valves.
3. Toilet seats.

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 water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

A. Water Closets WC-1, WC-1A: Wall mounted, top spud, accessible.

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 Standard America.

b. Capizzi.
c. Kohler Co.
d. TOTO USA, INC.
e. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Bowl:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Siphon jet.
d. Style: Flushometer valve.
e. Height: Standard.
f. Rim Contour: Elongated.
g. Water Consumption: 1.28 gal. per flush.
h. Spud Size and Location: NPS 1-1/2; top.

3. Flushometer Valve: WC-1. WC-1A.
4. Toilet Seat: Elongated rim, open front.
5. Support:

a. Standard: ASME A112.6.1M.
b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
c. Water-Closet Mounting Height: Standard and Handicapped/elderly according to ICC/ANSI A117.1.

2.2 FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves WCF1-A:

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. Coyne & Delany Co.
b. Gerber Plumbing Fixtures LLC.
c. Sloan Valve Company.
d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

9. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Consumption: 1.28 gal. per flush.
11. Minimum Inlet: NPS 1.
12. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats : All:

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 Standard America.
   b. Bemis Manufacturing Company.
   c. Centoco Manufacturing Corporation.
   d. Church Seats.
   e. Kohler Co.
   f. TOTO USA, INC.

2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.

2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Use carrier supports with waste-fitting assembly and seal.
2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079000 "Joint Sealants."

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224213.16 - COMMERCIAL URINALS

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. Urinals.
2. Flushometer valves.

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 urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals UR-1: Wall hung, back outlet, blowout.

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 Standard America.
b. Capizzi.

c. Kohler Co.

2. Fixture:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Strainer or Trapway: Open trapway with integral trap.
d. Water Consumption: Water saving.
e. Spud Size and Location: NPS 1-1/4; top.
f. Outlet Size and Location: NPS 2; back.
g. Color: White.

3. Flushometer Valve: Manual, low flow.
4. Waste Fitting:

a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.

5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

B. Urinals L-1A: Wall hung, back outlet, washout, accessible.

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 Standard America.
b. Capizzi.
c. Kohler Co.

2. Fixture:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Washout with extended shields.
d. Strainer or Trapway: with integral trap.
e. Water Consumption: Water saving.
f. Spud Size and Location: NPS 3/4, top.
g. Outlet Size and Location: NPS 2, back.
h. Color: White.

3. Flushometer Valve: Manual, low flow.
4. Waste Fitting:

a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.

5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

2.2 URINAL FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves L-1A:

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. Coyne & Delany Co.
   b. Gerber Plumbing Fixtures LLC.
   c. Sloan Valve Company.
   d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Consumption: 0.5 gal. per flush.
11. Minimum Inlet: NPS 3/4.
12. Minimum Outlet: NPS 1-1/4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use carriers without waste fitting for urinals with tubular waste piping.

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079000 "Joint Sealants."

3.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.16

SECTION 224216.13 - COMMERCIAL LAVATORIES

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. Lavatories.
2. Faucets.

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 lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017820 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory L-1: Vitreous china, wall mounted, with back.

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 Standard America.
    b. Briggs Plumbing Products, Inc.
    c. Crane Plumbing, L.L.C.
    d. Ferguson Enterprises, Inc.; ProFlo Brand.
    e. Kohler Co.

2. Fixture:

    a. Standard: ASME A112.19.2/CSA B45.1.
    b. Type: For wall hanging.
    c. Nominal Size: 19 by 16 inches.
    d. Faucet-Hole Punching: One hole.
    e. Faucet-Hole Location: Top.
    f. Color: White.
    g. Mounting Material: Chair carrier.

3. Faucet: Solid-Brass, Manually Operated Faucets.
4. Support: ASME A112.6.1M,Type II, concealed-arm lavatory carrier with escutcheons**.**

B. Lavatory L-1A: Wheelchair, vitreous china, wall mounted.

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 Standard America.
    b. Crane Plumbing, L.L.C.
    c. Ferguson Enterprises, Inc.; ProFlo Brand.
    d. Kohler Co.

2. Fixture:

    a. Standard: ASME A112.19.2/CSA B45.1.
    b. Type: Slab or wheelchair.
    c. Nominal Size: Rectangular, 27 by 20 inches.
    d. Faucet-Hole Punching: Three holes, 2-inch centers.
    e. Faucet-Hole Location: Top.
    f. Color: White.
    g. Mounting: For concealed-arm carrier.

3. Faucet: Solid-Brass, Manually Operated Faucets.
4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.

2.2 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets L-1, L-1A: Automatic-type, battery-powered, electronic-sensor-operated, mixing, solid-brass valve.

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 Standard America.
   b. Bradley Corporation.
   c. Chicago Faucets.
   d. Gerber Plumbing Fixtures LLC.
   e. Grohe America, Inc.
   f. Hydrotek International, Inc.
   g. Kohler Co.
   h. Moen Incorporated.
   i. Sloan Valve Company.
   j. Speakman Company.
   k. T & S Brass and Bronze Works, Inc.
   l. TOTO USA, INC.
   m. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. 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.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator.
12. Drain: Grid.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2.
2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/4.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079000 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

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.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079000 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a 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.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

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. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
   j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
   k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

   a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

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. Filled-system thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
7. Test-plug kits.
8. Sight flow indicators.
9. Orifice flowmeters.
10. Turbine flowmeters.
11. Impeller-turbine, thermal-energy meters.

B. Related Sections:

1. Section 231123 "Facility Natural-Gas Piping" for gas meters.

1.3 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

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. Ashcroft Inc.
   b. Marsh Bellofram.
   c. Palmer Wahl Instrumentation Group.
   d. REOTEMP Instrument Corporation.
   e. Weiss Instruments, Inc.

2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel ; 4-1/2-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

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. Trerice, H. O. Co.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Flo Fab Inc.
    d. Marsh Bellofram.

e. Miljoco Corporation.
f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
g. Weiss Instruments, Inc.
h. WIKA Instrument Corporation - USA.
i. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Open-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

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. Flow Design, Inc.
2. National Meter, Inc.
3. Peterson Equipment Co., Inc.
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic self-sealing rubber.

2.8 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flow Design, Inc.
2. National Meter, Inc.
3. Peterson Equipment Co., Inc.
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 FLOWMETERS

A. Orifice Flowmeters:

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. ABB; Instrumentation and Analytical.
   b. Bell & Gossett; ITT Industries.
   c. Meriam Process Technologies.
   d. Preso Meters; a division of Racine Federated Inc.
   e. S. A. Armstrong Limited; Armstrong Pumps Inc.

2. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.

a. Design: Differential-pressure-type measurement for water.
b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
c. Minimum Pressure Rating: 300 psig.
d. Minimum Temperature Rating: 250 deg F.

5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.

a. Scale: Gallons per minute.
b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot hoses, with carrying case.

a. Scale: Gallons per minute.
b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

7. Display: Shows rate of flow, with register to indicate total volume in gallons.
8. Conversion Chart: Flow rate data compatible with sensor and indicator.
9. Operating Instructions: Include complete instructions with each flowmeter.

B. Turbine Flowmeters:

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. ABB; Instrumentation and Analytical.
b. Data Industrial Corp.
c. EMCO Flow Systems; a division of Spirax Sarco, Inc.
d. Hoffer Flow Controls, Inc.
e. Midwest Instruments & Controls Corp.
f. ONICON Incorporated.

2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.

a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
c. Minimum Pressure Rating: 150 psig.
d. Minimum Temperature Rating: 180 deg F.

5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Accuracy: Plus or minus 1-1/2 percent.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.

8. Operating Instructions: Include complete instructions with each flowmeter.

2.10 THERMAL-ENERGY METERS

A. Impeller-Turbine, Thermal-Energy Meters:

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. Data Industrial Corp.
   b. Hoffer Flow Controls, Inc.
   c. ISTEC Corporation.
   d. ONICON Incorporated.

2. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.

   a. Design: Total thermal-energy measurement.
   b. Minimum Pressure Rating: 150 psig.
   c. Minimum Temperature Range: 40 to 250 deg F.

4. Temperature Sensors: Insertion-type transducer.
5. Indicator: Solid-state, integrating-type meter; for wall mounting.

   a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
   b. Battery Pack: Five-year lithium battery.

6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
8. Strainer: Full size of main line piping.
9. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids.

K. Install test plugs in piping tees.

L. Install flow indicators in piping systems in accessible positions for easy viewing.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

N. Install flowmeter elements in accessible positions in piping systems.

O. Install wafer-orifice flowmeter elements between pipe flanges.

P. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

Q. Install permanent indicators on walls or brackets in accessible and readable positions.

R. Install connection fittings in accessible locations for attachment to portable indicators.

S. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

T. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Inlet and outlet of each hydronic coil in air-handling units.
4. Two inlets and two outlets of each hydronic heat exchanger.
5. Outside-, return-, supply-, and mixed-air ducts.

U. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Compact-style, liquid-in-glass type.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Compact-style, liquid-in-glass type.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Compact-style, liquid-in-glass type.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

D. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Compact-style, liquid-in-glass type.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Air Ducts: Minus 40 to plus 110 deg F .

C. Scale Range for Air Ducts: 0 to 100 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:

1. Liquid-filled Open-front, pressure-relief , direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be one of the following:

1. Liquid-filled Open-front, pressure-relief , direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Chilled-Water Piping: Orifice or Turbine type.

B. Flowmeters for Heating, Hot-Water Piping: Orifice or Turbine type.

3.9 THERMAL-ENERGY METER SCHEDULE

A. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine type.

B. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine type.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

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. Brass ball valves.
2. Bronze ball valves.
3. Iron, grooved-end butterfly valves.
4. High-performance butterfly valves.
5. Bronze lift check valves.
6. Bronze swing check valves.
7. Iron swing check valves.
8. Iron swing check valves with closure control.
9. Bronze gate valves.

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Red-White Valve Corporation.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

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 Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Sure Flow Equipment Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-72.
   b. CWP Rating: 200 psig.
   c. Body Design: Split body.
   d. Body Material: ASTM A 126, gray iron.
   e. Ends: Flanged.
   f. Seats: PTFE or TFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
   i. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. NIBCO INC.
   f. Red-White Valve Corporation.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 150 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

B. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

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. Bray Controls; a division of Bray International.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. NIBCO INC.
f. Red-White Valve Corporation.
g. Spence Strainers International; a division of CIRCOR International.
h. Tyco Valves & Controls; a unit of Tyco Flow Control.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:

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. Kennedy Valve; a division of McWane, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

2.6 HIGH-PERFORMANCE BUTTERFLY VALVES

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. Crane Co.; Crane Valve Group; Flowseal.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Milwaukee Valve Company
   e. NIBCO INC.

2. Description:

   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.

2.7 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

B. Class 125, Lift Check Valves with Nonmetallic Disc:

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. Hammond Valve.
b. Milwaukee Valve Company.
c. Mueller Steam Specialty; a division of SPX Corporation.
d. NIBCO INC.
e. Red-White Valve Corporation.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: NBR, PTFE, or TFE.

2.8 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. NIBCO INC.
f. Red-White Valve Corporation.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.

d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.9 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. NIBCO INC.
f. Red-White Valve Corporation.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.10 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

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 Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. NIBCO INC.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, RS Bronze Gate Valves:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. NIBCO INC.
e. .
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe or ball valves.
4. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with brass trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, disc.
4. High-Performance Butterfly Valves: Class 150, single flange.
5. Iron Swing Check Valves: Class 125, metal seats.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, full port, brass with brass trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
4. High-Performance Butterfly Valves: Class 150 single flange.
5. Iron Swing Check Valves: Class 125, metal seats.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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 pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings:Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding Procedure Specifications.

B. Welding Procedures Qualifications Records.

C. Welders Qualification Reports.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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. Cooper B-Line, Inc.
   b. Flex-Strut Inc.
   c. Thomas & Betts Corporation.
   d. Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.
8. Paint Coating: Vinyl.

B. Non-MFMA Manufacturer Metal Framing Systems:

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. Anvil International; a subsidiary of Mueller Water Products Inc.
   b. Haydon Corporation; H-Strut Division.
   c. NIBCO INC.
   d. PHD Manufacturing, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

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:

B. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Clement Support Services.
2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Piping Technology & Products, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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 a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
8. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
9. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
10. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
11. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

12. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
13. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
14. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
15. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

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. Elastomeric isolation mounts.
2. Housed-spring isolators.
3. Pipe-riser resilient supports.
4. Resilient pipe guides.
5. Spring hangers.
6. Vibration isolation equipment bases.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. 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 each vibration isolation device.

1. Contractor shall provide and submit vibration control designs.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Procedure Specifications.

B. Welding Procedure Qualifications Records.

C. Welding Qualification Reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirementsprovide products by the following:

a. Ace Mountings Co., Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Isolation.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.2 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top housing with attachment and leveling bolt.

2.3 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psigon isolation material providing equal isolation in all directions.

2.4 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.5 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. Vibration Eliminator Co., Inc.
    d. Vibration Isolation.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.6 VIBRATION ISOLATION EQUIPMENT BASES

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. California Dynamics Corporation.
2. Kinetics Noise Control.
3. Mason Industries, Inc.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Stencils.
5. Valve tags.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: See paragraph 3.4.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting"

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Chilled-Water Piping:

a. Background Color: Green.
b. Letter Color: White.

2. Heating Water Piping:

    a. Background Color: Red.
    b. Letter Color: White.

3. Refrigerant Piping:

    a. Background Color: Black.
    b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

    1. Blue: For cold-air supply ducts.
    2. Yellow: For hot-air supply ducts.
    3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
    4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

    1. Valve-Tag Size and Shape:

        a. Chilled Water: 1-1/2 inches, round.
        b. Refrigerant: 1-1/2 inches, round.
        c. Hot Water: 1-1/2 inches, round.
        d. Gas: 1-1/2 inches, round.

    2. Valve-Tag Color:

        a. Chilled Water: Green.
        b. Refrigerant: Green.
        c. Hot Water: Green.

d. Gas: Yellow.

3. Letter Color:

a. Chilled Water: White.
b. Refrigerant: White.
c. Hot Water: White.
d. Gas: Black.

END OF SECTION 230553

SECTION 230593 - TEST AND BALANCE Cx

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Perform test and balance work by a Test and Balance Agency which is engaged solely in full time test and balance work, is a member of the Associated Air Balance Control (AABC) or approved equal, and is selected and employed by the contractor.

B. Perform test and balance in accordance with AABC Standards.

C. Contract to the Test and Balance Agency shall be issued by the contractor. Coordination with the agency at the job site shall be the responsibility of the contractor in order to ensure proper scheduling and operation of the systems. All correspondence (reports, letters and communications) between any parties shall have copies sent directly to the COTR and contractor.

D. The TAB agency shall review construction plans and specifications. If any discrepancies are noted which would hinder balancing, notify the COTR with copy to the contractor.

E. Make inspections of the job during construction for proper installation of the system(s) and of balancing aids in the system(s). Any discrepancies noted shall be brought to the attention of the contractor and COTR. The number of inspections varies with the size and complexity of the job and shall be adequate for the purpose intended. Report ALL job visits in writing - MANDATORY.

1.2 RESPONSIBILITIES OF PROJECT CONTRACTOR

A. The contractor shall:

1. Provide approved Test and Balance Agency with copy of plans and specifications upon issue of construction documents.
2. Have the building and HVAC systems in operational readiness for TAB work to begin.
3. Correct prompt deficiencies of materials and workmanship identified as delaying completion of TAB work.
4. Be responsible for any added costs to the COTR resulting from his failure to have the building and HVAC systems ready or from his failure to correct deficiencies promptly.

B. Complete operational readiness of the building requires that construction status of the building shall permit closing of doors, windows, ceilings installed, etc., to obtain projected operating conditions.

C. Complete operational readiness of the air conditioning systems requires that the following be accomplished:

1. Air Distribution Systems:

a. Verify installation conforms to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by specifications.
b. All volume, control, fire and smoke dampers properly located and functional. All dampers shall be fully open. MVD gradients and spin damper handles should be exposed through insulation. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.
c. All supply, return, exhaust and transfer grilles, registers, diffusers, terminal boxes and filters installed.
d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be sealed to eliminate bypass or leakage of air.
e. All fans operating at full load and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating. Check motor amperage and verify that it is under nameplate rating.

2. Water Circulating Systems:

a. Check and verify pump alignment and rotation. Verify location of thermometers, gages, and PT test plugs.
b. Open all valves to full open position. Close bypass stop valves. Set mixing valves to full flow through system components. Remove and clean all strainers. Verify specified pipe cleaning has taken place. Repeat operation until circulating water is clean.
c. Record pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Verify heater elements in motor starters to be of proper size and rating.
d. All water circulating systems shall be full and free of air; expansion tanks set for proper water level; all air vents installed at high points of systems and operating freely. System static pressure to be set minimum 5 psig above highest system elevation.
e. Verify that piping to coils is complete and set for counter flow. Verify location of thermometers, gauges, PT test plugs, and flow balancing/measuring valves.

3. Automatic Controls:

a. Verify that all control components are installed and functional in accordance with project requirements, including all electrical interlocks, damper sequences, temperature resets, and safeties.
b. Verify that pressure controllers are calibrated and control variable speed motor controllers as required to maintain a stable pressure.
c. All controlling instruments calibrated and set for designed operating conditions.

4. Notification of System Readiness: After completion of the work above, the contractor shall notify the TAB firm and COTR certifying that the work has been accomplished and that the building and HVAC systems are in readiness for testing, adjusting, and balancing.

D. As part of this project contract, the contractor shall make any changes in the sheaves, belts and dampers required for correct balance as required by the TAB firm.

E. The contractor shall provide and coordinate services of qualified, responsible contractors, suppliers and personnel as required to correct, repair, or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.

F. In order that all systems may be properly tested, balanced, and adjusted, the contractor shall operate systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB.

G. Project schedules shall provide sufficient time to permit the completion of TAB services prior to COTR occupancy.

H. The plans and specifications have indicated valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel shall be reported to the contractor and COTR and corrected by the contractor immediately so the balancing work can proceed.

1.3 SUBMITTALS

A. Qualifications:

1. The firm shall submit six (6) completed projects of like size and scope. Provide references for each project.
2. The test and balance firm shall submit a resume for the individual proposed to directly supervise the project. The supervisory personnel for the test and balance firm shall be certified test and balance engineers. All project managers and technicians shall be permanent, full-time employees of the agency.
3. The test and balance firm shall submit a list of its calibrated instrumentation to perform the work.
4. The Test and Balance firm shall submit preliminary copies of forms referenced in Part 3.

B. TAB Plan:

1. The submitted plan will include:

a. Statement that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
b. An explanation of the intended use of the building control system.
c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
e. Final test report forms to be used.
f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or

relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
i. The identification and types of measurement instruments to be used and their most recent calibration date.
j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.
l. Details of whether and how minimum outside air cfm will be verified and set and for what level (total building, zone, etc.).
m. Details of how building static and exhaust fan / relief damper capacity will be checked.
n. Proposed selection points for sound measurements and sound measurement methods.
o. Details of methods for making any specified coil or other system plant capacity measurements.
p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
q. Details regarding specified deferred or seasonal TAB work.
r. Details of any specified false loading of systems to complete TAB work.
s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
t. Details of any required interstitial cavity differential pressure measurements and calculations.
u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
v. Plan for formal progress reports (scope and frequency).
w. Plan for formal deficiency reports (scope, frequency and distribution).

C. TAB Report

1. TAB activities shall culminate in a report to be provided in triplicate to the COTR. The intent of the final report is to provide a reference of actual operating conditions for the COTR's operating personnel.
2. Any unresolved problems shall be reported in a general remarks section in front of the test and balance report.
3. Any unusual operations or pertinent remarks which may aid the maintenance personnel or ease the reading of the report shall be made in the general remarks section of the report.
4. All comment sheets (punch lists) shall be signed by the contractor to acknowledge receipt. Any outstanding items at the time of completion shall be included in the report.
5. All operating data and final tests shall be reported in the final report. This data shall include, but not necessarily be limited to the scope of work outlined in this specification.

6. TAB contractor shall compile an Excel spreadsheet for all terminal boxes, listing each box by its unique identification number, the inlet flow area established by the box manufacturer, the manufacturer's gain factor for the box, final TAB calibrated gain factor for the box if field calibrated, and the ratio of the calibrated gain factor to the manufacturer's gain factor.
7. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must be done on-site by permanently employed technicians or engineers of the firm.
8. The report shall be certified and approved by the firm's test and balance engineer. The report shall be recorded on standard forms.

1.4 DOCUMENTS

A. The contractor shall furnish to the TAB firm the following:

1. One set of mechanical specifications.
2. Three sets of mechanical drawings.
3. All pertinent addenda and change orders.
4. One set of control submittal drawings.
5. Approved submittal data on equipment installed, and related changes as required to accomplish the TAB test procedures outlined below.

1.5 RELATED SECTIONS

A. The Test and Balance contractor shall perform the commissioning activities specified in Sections 01 91 13 and 23 08 10.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 RESPONSIBILITIES OF THE TAB FIRM

A. The TAB personnel shall check, adjust, and balance the components of the HVAC system which will result in minimum noise, specified temperature, and air flow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents.

3.2 LIAISON AND EARLY INSPECTION

A. The personnel on the job shall act as liaison between the COTR and contractor. They shall inspect the installation of piping systems, ductwork systems, control systems, and other component parts of the HVAC systems during the construction stage to verify proper arrangement and adequate provisions for the testing and balancing.

B. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the contractor shall be advised in writing so that the condition can be corrected by the contractor. The TAB firm shall suggest solutions to noted problems. Data from malfunctioning equipment shall not be recorded in the final TAB report.

3.3 ACTUAL TESTING AND BALANCING PROCEDURES

A. Airside:

1. Supply Air:

   a. Fans checked for rotation, amperage, static pressure, etc.
   b. Terminal boxes set to maximum and minimum cfm and supply outlets balanced to within 5% of design cfm.
   c. Main supply duct pitot tube traverse and adjustment of fan speed to produce design cfm while maintaining minimum system static pressure for proper terminal box operation.
   d. Replace adjustable sheaves with fixed sheaves after completion of T&B.

2. Return Air:

   a. Fans checked for rotation, amperage, static pressure, etc.
   b. With supply system in the maximum mode, traverse and adjust return fan to design cfm.
   c. With supply system in the maximum mode, proportion return inlets to within 5% of design cfm.
   d. Replace adjustable sheaves with fixed sheaves after completion of T&B.

3. Outside Air:

   a. Fans checked for rotation, amperage, static pressure, etc.
   b. With supply system in the maximum mode, traverse and adjust minimum outside air damper and/or fan to design cfm.
   c. Replace adjustable sheaves with fixed sheaves after completion of T&B.

4. Exhaust Air:

   a. Fans checked for rotation, amperage, static pressure, etc.
   b. With supply system in the maximum mode, traverse and adjust exhaust fan to design cfm.
   c. Proportion exhaust inlets to within 5% of design cfm.
   d. Replace adjustable sheaves with fixed sheaves after completion of T&B.

5. Diffusers, Registers, and Grilles:

   a. Balance each supply, return and exhaust air outlet within 5% of design cfm.
   b. Check and/or adjust pressure relationships so that each positive pressure and each negative pressure area is at least 10% positive or negative as appropriate.

6. After completion, take total air-handling system static profile and record all final statics, amperages, rpm, cfm, etc.

B. Waterside:

1. Chilled Water:

a. Check system for cleanliness.
b. With all chilled water valves calling for full cooling, test, set and record each pump head and flow.
c. Test, set and record pressure drop and flow through each flow balancing station.
d. Test, set and record pressure drop and flow through each cooling coil.
e. Verify that piping system is vented.
f. Verify removal of pump start up strainer and replacement with operating strainer.

2. Heating Hot Water

a. Check system for cleanliness.
b. With all heating water valves calling for full heating, test, set and record each pump head and flow.
c. Test, set and record pressure drop and flow through each flow balancing station.
d. Test, set and record pressure drop and flow through each heating coil.
e. Verify that piping system is vented.
f. Verify removal of pump start up strainer and replacement with operating strainer.

C. Controls:

1. AHU Controls:

a. Check temperature controls for proper calibration and setpoint.
b. Check economizer controls for proper damper operation and control calibration.
c. Check supply/return volumetric synchronization system under maximum and minimum conditions for proper operation.
d. Check static pressure control under maximum and minimum conditions for proper operation.

2. Thermostats and Controllers:

a. Check for proper control of valves, dampers, terminal boxes, exhaust fans, etc.
b. Set at design set point.

D. Capacity and Performance Test:

1. Cooling Coils:

a. Test, set and record pressure drop and flow through each coil.
b. Measure entering and leaving dry and wet bulb air temperatures with glass stem, mercury thermometers accurate to 1/2 degrees F.
c. Measure entering and leaving water temperature with glass stem, mercury thermometer if thermometer wells are provided. If P.T. plugs are provided, use a

bi-metal thermometer which reads in 1 degree F. increments and use the same thermometer for both supply and return water temperature measurements.

d. Record final temperatures, BTU/HR. and GPM.

e. Convert actual test conditions to design conditions to insure design coil capacities at design temperatures.

2. Heating Coils (Air Handling Unit and Preheat Only):

a. Test, set and record pressure drop and flow through each coil.

b. Measure entering and leaving dry and wet bulb air temperatures with glass stem, mercury thermometers accurate to 1/2 degrees F.

c. Measure entering and leaving water temperature with glass stem, alcohol thermometer if thermometer wells are provided. If P.T. plugs are provided, use a bi-metal thermometer which reads in 1 degree F. increments and use the same thermometer for both supply and return water temperature measurements.

d. Record final temperatures, BTU/HR. and GPM.

e. Convert actual test conditions to design conditions to insure design coil capacities at design temperatures.

3. Terminal Box Heating Coils: Test, set and record flow through terminal box heating coil.

4. Thermostat Calibration:

a. Measure and record dry and wet bulb temperatures at each thermostat.

b. Report any thermostat which is not controlling with +/-1-1/2 degree F.

5. Control Temperature Readouts:

a. Test actual temperature next to sensor (if possible) and compare to readout.

b. Report any sensor which is not within +/-1/1-2 degrees F.

3.4 REPORTS

A. Problems Encountered: Any items not installed, improperly installed or not functioning properly shall be reported to the contractor.

3.5 CALLBACK

A. Test and Balance Corporation shall retest any unresolved problems noted in the final report. The revised results shall be forwarded after completion of test.

B. At the discretion of the COTR before final acceptance of the TAB report, the report data shall be verified one time on the job site by selection of random check points in the presence of the COTR. Representatives of the testing firm shall be present and provide the necessary equipment for test data verifications.

C. The firm shall be responsible for testing, adjusting, balancing, and reporting on the performance of all fans, dampers, air distribution devices, pumps and heat exchangers, the flow through all coils, pumps and heat exchangers, and the power consumption of all motors. The contractors

and the suppliers of the equipment installed shall cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiency.

D. Make one (1) inspection within ninety (90) days after occupancy of the building to insure that satisfactory conditions are being maintained.

3.6 OPPOSED SEASON TESTING

A. This service allows for testing of equipment that, due to extreme weather conditions, cannot be accurately tested at the time of the initial balance. If a project is balanced during the summer, the opposed season testing is performed during the winter months and vice-versa.

B. During the opposed season testing, any necessary modifications to the initial adjustment required to produce optimum operation of the system components shall be made to produce the proper seasonal conditions in each conditioned space. At the time of opposite season testing, the COTR shall be given timely notification before any readings or adjustments are made so that he may participate.

END OF SECTION 230593

SECTION 230713 - DUCT 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 insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches square.
2. Sheet Jacket Materials: 12 inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.

e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2 or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 1-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
b. Eagle Bridges - Marathon Industries; 501.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
2) GEMCO; Peel & Press.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.

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 & F Wire.

2.11 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping"irestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

D. Concealed, rectangular, return, exhaust, and outdoor air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

E. Concealed, return-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

F. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Exposed, round and flat-oval, outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

H. Exposed, rectangular, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

I. Exposed, rectangular, return, exhaust, and outdoor air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. FSK or ASJ.

D. Ducts and Plenums, Exposed:

1. FSK or ASJ.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT 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 insulating the following HVAC equipment that is not factory insulated:

1. Chilled-water pumps.
2. Heating, hot-water pumps.
3. Expansion/compression tanks.
4. Air separators.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
2. Sheet Form Insulation Materials: 12 inches square.
3. Sheet Jacket Materials: 12 inches square.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Sheet and K-FLEX LS.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Super-Stik.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H .B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated tank heads and tank side panels.

D. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 491 AWF FSK.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    c. Compac Corporation; 110 and 111.
    d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2.10 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.040 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.6 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.7 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Chilled-water pump insulation shall bethe following:

1. Cellular Glass: 3 inches thick.

D. Heating-hot-water pump insulation shall bethe following:

1. Cellular Glass: 3 inches thick.

E. Heating-hot-water expansion/compression tank insulation shall bethe following:

1. Cellular Glass: 1-1/2 inches thick.

F. Chilled-water air-separator insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.

G. Heating-hot-water air-separator insulation shall bethe following:

1. Cellular Glass: 3 inches thick.

3.8 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. PVC: 20 mils thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. PVC: 20 mils thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING 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 insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Chilled-water piping, indoors.
3. Heating hot-water piping, indoors.
4. Refrigerant suction and hot-gas piping, indoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
2. Sheet Form Insulation Materials: 12 inches square.
3. Jacket Materials for Pipe: 12 inches long by NPS 2.
4. Sheet Jacket Materials: 12 inches square.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pittsburgh Corning Corporation; Foamglas.

2. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following :

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following :

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

7. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

    1. Products: Subject to compliance with requirements, provide one of the following:

        a. Johns Manville; Zeston.
        b. P.I.C. Plastics, Inc.; FG Series.
        c. Proto Corporation; LoSmoke.
        d. Speedline Corporation; SmokeSafe.

    2. Adhesive: As recommended by jacket material manufacturer.
    3. Color: White.
    4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

        a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 491 AWF FSK.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    c. Compac Corporation; 110 and 111.
    d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

    a. Flexible Elastomeric: 3/4 inch thick.

B. Chilled Water above 40 Deg F:

1. NPS 12 and Smaller: Insulation shall be one of the following:

    a. Cellular Glass: 1-1/2 inches thick.
    b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 12 and Smaller: Insulation shall be one of the following:

    a. Cellular Glass: 2 inches thick.
    b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.

E. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Flexible Elastomeric: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. PVC: 30 mils thick.

D. Piping, Exposed:

1. PVC: 30 mils thick.

END OF SECTION 230719

SECTION 230810 – MECHANICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The purpose of this section is to specify the Mechanical Contractor's, TAB Contractor's, and Controls Contractor's responsibilities in the commissioning process.

B. The list of commissioned equipment and systems is found in SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS.

C. Commissioning requires the participation of the Mechanical Contractor, the TAB Contractor, and the Controls Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The Mechanical Contractor, TAB Contractor, and Controls Contractor shall comply with all parts of SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to the Mechanical Contractor, TAB Contractor, and Controls Contractor in the Contract Documents.

1.2 RESPONSIBILITIES

A. In addition to the responsibilities listed in Section 01 91 13, the commissioning responsibilities of the Mechanical Contractor, TAB Contractor, and Controls Contractor are as follows (all references apply to commissioned equipment only):

B. Include and itemize the cost of commissioning in the contract price.

C. Provide requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures. Typically, this will include detailed manufacturer installation, start-up, operating, troubleshooting, and maintenance procedures, full details of any owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be provided to the CA.

D. Provide assistance to the CA in preparation of the specific functional performance verification procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

E. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA weekly.

F. Correct all issues and problems found during the startup process and TAB work prior to functional performance verification.

G. Provide skilled technicians to execute starting of equipment and to execute the functional performance verifications. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem-solving.

H. Correct issues and retest the equipment.

I. Provide training of the Owner's operating personnel as specified.

J. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

1.3 MECHANICAL CONTRACTOR'S RESPONSIBILITIES.

A. The commissioning responsibilities of the mechanical contractor, in addition to those listed in Paragraph 1.2 are:

B. Provide startup for all HVAC equipment, except for the building automation control system.

C. Assist and cooperate with the TAB contractor and CA by:

1. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
2. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
3. Install a P/T plug at each water sensor which is an input point to the control system.

D. Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.

E. Notify the CA when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment, TAB, and commissioning processes will occur.

F. Review and accept prefunctional checklists provided by the CA.

G. For all commissioned equipment, develop a full start-up plan using manufacturers' start-up procedures and the prefunctional checklists from the CA. Provide manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CA for review. Refer to SECTION 01 91 13 – GENERAL COMMISSIONING to CA for further details on startup plan preparation.

H. During the startup process, execute and document the mechanical-related portions of the prefunctional checklists provided by the CA and provide to the CA weekly.

I. Evaluate issues identified in the prefunctional checks and, in collaboration with the CA and other contractors, recommend corrective action.

J. Inform the CA 48 hours prior to a start-up on any piece of commissioned equipment.

1.4 CONTROLS CONTRACTOR'S RESPONSIBILITES

A. The commissioning responsibilities of the controls contractor, in addition to those listed in Paragraph 1.2 are:

B. Sequences of Operation Submittals (submitted in 23 09 23).

C. Control Drawings Submittal (submitted in 23 09 23).

D. Submit bound copies of trend data (submitted in 23 09 23).

E. Assist and cooperate with the TAB contractor in the following manner:

1. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB.
2. Provide the TAB contractor any needed unique instruments for setting terminal unit boxes and instruct TAB contractor in their use (handheld control system interface for use around the building during TAB, etc.).
3. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.
4. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

F. Assist and cooperate with the CA in the following manner:

1. Perform a complete checkout and verification of the controls and instrumentation before total system commissioning begins.
2. Using a skilled technician who is familiar with the building, execute the functional testing of the controls system as specified for the controls contractor in the Commissioning Plan. Assist in the functional testing of all equipment specified in the Commissioning Plan.
3. Execute all control system trend logs specified in the Commissioning Plan.
4. Provide a copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.

G. Sign each prefunctional checklist, certifying that each controlled device and system has been completed prior to functional testing.

H. The controls contractor shall host the server function of the UCS system at the building locally. The local server will be utilized through all testing and check out phases, including commissioning.

I. The Controls Contractor shall keep the CA informed of all changes.

1.5 TAB CONTRACTOR'S RESPONSIBILITIES.

A. The responsibilities of the TAB contractor, in addition to those listed in Paragraph 1.2, are:

B. Submit the TAB plan (submitted in 23 05 93).

C. Provide reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests, a running log of events and issues, and lists of completed tests to the CA and PM at least once a week.

D. Communicate via e-mail to the controls contractor and the CA all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

E. Provide a draft TAB report to the CA within two weeks of completion. The report will contain a full explanation of the methodology, assumptions, and the results in a clear format with designations of all uncommon abbreviations and column headings. The report shall follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.

F. Provide the CA with any requested data, gathered, but not shown on the draft TAB report.

G. Provide a final TAB report for the CA.

H. Conduct functional performance tests and checks on the original TAB as specified in the Commissioning Plan.

I. TAB contractor shall meet with CA after completion of TAB to:

1. Go over the final TAB report, explaining the layout and meanings of each data type.
2. Discuss any outstanding deficient items in control, ducting, piping or design that may affect the proper delivery of air or water.
3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans, and pumps that are close to or are not meeting their design capacity.
4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
5. Other salient information that may be useful for facility operations, relative to TAB.

1.6 RELATED SECTIONS

A. Refer to SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS for systems to be commissioned.

B. Refer to SECTION 23 05 93 for Testing, Adjusting, and Balancing.

C. Refer to SECTION 23 09 23 for Direct Digital Control/Utility Control System.

D. Refer to SECTION 23 09 00 for HVAC Instrumentation Controls

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. The Mechanical Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Division. See 01 91 13 for additional requirements.

PART 3 - EXECUTION

3.1 STARTUP and PREFUNCTIONAL CHECKLISTS

A. The Mechanical and Controls Contractors shall follow the start-up procedures listed in the Responsibilities list in this section and in SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS. The Mechanical Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents.

3.2 TAB

A. TAB shall begin only after prefunctional checklists are completed and approved by the CA.

3.3 FUNCTIONAL PERFORMANCE VERIFICATION

A. Functional verification shall start only after Prefunctional Checklists and TAB report have been approved by the CA.

3.4 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The Mechanical Contractor shall compile and prepare documentation for all equipment and systems and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section and Section 01 78 20, prior to the training of owner personnel.

B. The CA shall receive a copy of the O&M manuals for review.

END OF SECTION 230810

SECTION 230900 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work specified under this section of the specifications includes furnishing, installing, programming, and placing into operation the DDC/BAS systems.

B. The DDC/BAS systems shall be furnished and installed under this section of the specifications and shall consist of microprocessor based digital system controllers. The systems shall have the ability for extension to other buildings by LAN Network. The systems shall be complete in every respect, including all auxiliary and accessory items as required, and shall be thoroughly coordinated so as to provide a compatible and completely workable system.

C. Provide a complete control system including electrical interlocks, wiring, conduit, relays, switches, control transformers, and other devices as required to accomplish automatic control of the mechanical systems. Refer to drawings for details.

D. All systems shall be guaranteed against defects of any nature and to operate properly for a period of not less than 12 months after final acceptance of the job by the COTR. During this period, the BAS manufacturer shall service and adjust the systems as required for proper operation, replacing components as required.

1.2 SUBMITTALS

A. Complete shop drawings

B. Product Data

C. List of control valve CV and pressure drops

D. List of control dampers

E. Written sequences of operations

F. Diagrams indicating panels, gauges, components, spring ranges, and setpoints

G. Complete composite wiring diagrams indicating all equipment interlocks for entire control system.

1.3 RELATED SECTIONS

A. Section 23 08 10 - MECHANICAL SYSTEMS COMMISSIONING” for controls contractor responsibilities in the commissioning process.

PART 2 - PRODUCTS

2.1 ELECTRONIC AND ELECTRIC CONTROL COMPONENTS

A. Smoke Detectors: Install duct-mounted smoke detectors at locations indicated on drawings and in accordance with published smoke detector installation requirements. Smoke detectors to be furnished to Division 23 by Division 26.

B. Freezestats (Low Limit Binary Type): Provide single, custom length Freon-filled capillary tube type with sensing element actuated by temperature on any one foot portion. Sensor shall be a single element with length of one linear foot for every one square foot of coil face area. Freezestats to be UL approved, manual reset type.

C. Averaging Temperature Sensors (Mixed Air, Preheat, Etc.): Provide single, custom length Freon-filled capillary tube type sensing element. Accuracy shall be +/- 0.3 degrees F. Sensor shall be single element with length of one linear foot for every one square foot of coil face area.

D. Control Valves: Two-inch and smaller water service valves to be screw connected chrome plated brass ball type with characterized port to allow equal percentage throttling. Valve pressure rating to be in accordance with piping and fitting specifications Section 23 21 13. (Minimum 125 psi operating pressure.) Valve actuators to be selected to close valves against pump shutoff head pressure. Provide stainless steel stem with removable composition disc and self-adjusting spring-loaded Teflon packing. Two position water valves to be line size or one line size smaller than connecting piping with maximum 1 psi water pressure drop. Modulating water valves to have equal percentage flow characteristics and be sized for maximum 4 psi water pressure drop. Zone type, tri-state, pulse type, or similar non-proportional control valves/actuators are not acceptable.

E. Automatic Control Dampers: Ultra low-leak automatic control dampers to be Arrow Pin Lock opposed-blade dampers for modulating control and parallel blades for 2-position control or approved equal. Frames and blades to be minimum 16 gauge extruded aluminum or galvanized steel construction with 4" to 6" deep frame and 8" maximum width blades. Pivot rods to be 1/2" diameter, extruded aluminum or plated steel. Bearings to be corrosion resistant. Install blade linkage hardware in angle or channel frame section out of airstream. All hardware to be corrosion resistant. Seals to be replaceable extruded vinyl or silicone rubber blade seals and flexible metal compression type jamb seals. Dampers to have maximum 4 cfm per square foot leakage at 1" water gauge static pressure and 8 cfm per square foot leakage at 4" water gauge static pressure, verified by independent testing laboratory.

F. Electronic Actuators: Actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch is not acceptable. For power-failure/safety applications, a mechanical, spring return mechanism shall be used. Non-mechanical forms of fail-safe are not acceptable. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by changing mounting orientation. Proportional actuators shall accept a 2 to 10 VDC or 4 to 20 mA and provide a 2 to 10 VDC position feedback signal. 24 VAC/DC actuators shall not require more than 15 VA for AC or 8 watts for DC applications. All non-spring return actuators shall have an external manual gear release to aid in installation and allow manual positioning when the actuator is not powered. All actuators shall have an external direction of rotation switch to aid in installation and provide

proper control response. Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box. Provide cover mounted control transformer for 120-VAC power supply. The actuators shall be U.L. listed.

G. Volumetric Devices: Air Flow Sensors and Indicating Transmitters

1. Fan Inlet Piezometer Air Flow Sensors and Indicating Transmitters shall be factory mounted in the air handling units. They shall be piezometer type average velocity sensors designed for installation inside the inlet ring of centrifugal fans accurate to +/- 1.5% measurement accuracy. There shall be no portions of device protruding into inlet cone.

2. Duct airflow probes shall be pitot type average velocity sensors designed for installation inside the inlet bell/funnel of centrifugal, plug, in-line centrifugal, and vane axial fans. Provide fan inlet airflow measuring probes with +/- 2% accuracy to be Paragon Controls Inc. FE-1050.

3. The airflow transmitter shall be an industrial quality, electronic solid state, ultra low span, ½ percent accuracy transmitter with integral square root, scaling, and output filter with indication. Each transducer shall be provided with a microprocessor digital readout meter, operating independent of all other control devices. This unit to provide a direct digital readout of the air volume as derived from the total and static input signals received from the respective air flow measuring element. The meter shall have a digital readout and 3 way zeroing valve for zero verification and calibration. Readout to be flush mounted on the enclosure door. The meter shall be calibrated to an accuracy of +/- 2% of span. Area factor input for respective inlet probes to be adjustable via a keypad. Provide individual airflow transmitters, especially selected for the required spans of each of the above primary processor shall to be Paragon Controls Inc. ModelMT-1.

H. Water Flow Meters:

1. Water flow meters shall be installed in strict accordance with manufacturer’s instruction and with minimum upstream and downstream straight length as required for specified measurement accuracy.

2. For chilled water and hot water applications in pipe sizes 3” to 72” the flow meter construction shall be 316 stainless steel wetted metal components with polypropylene sensing head, insertion type suitable for 400 psi pressure and 15 to 250 degree F temperature. Provide ball type isolation valve and all necessary installation hardware to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to design pressure. Meter accuracy shall be within ± 1.0% of rate between flow velocities of 2 to 20 feet per second and +/- 0.02 ft/s at 0.25 ft/s to 2 ft/s. Meter flow range shall be 0.25 ft/s to 20 ft/s (80:1 turndown). Output signal shall be selectable: 4-20mA, 0-10 V or 0-5 V. Water flow meter shall be Onicon Model F-3500 Insertion Electromagnetic Flow Meter. McCrometer, Inc. Multi-Mag or Ultra-Mag selected for application shall be acceptable as an alternate.

3. Bi-directional meters shall be the Onicon FB-1210 Insertion Dual Turbine Meter and shall include an isolated contact closure output for direction. Meter accuracy shall be within ± 0.5% of reading at the calibrated velocity, maximum +/- 1.0 percent of reading between flow velocities of 3 to 30 feet per second 10:1 and +/- 2.0% of reading at 0.4 ft/s

to 20 ft/s 50:1. Output signal available are 4-20mA or 0-10 V. Water flow meter shall be Onicon Model F-1210 Insertion Dual Turbine Flow Meter.

I. Energy (BTU) Measurement System:

1. The entire Energy Measurement System shall be provided by a single manufacturer, and shall consist of a water flow meter, two temperature sensors, a BTU meter, temperature thermowells, and all required mechanical installation hardware. A certificate of calibration shall be provided with each system. The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be serial network (protocol conforming to BACnet MS/TP, LONWORKS, JCI-N2 or Siemens-P1 as required by controls manufacturer). Each BTU meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required). BTU meter shall be Onicon System-10 BTU Meter.

2. Temperature Sensors: Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within +0.15 degrees F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).

3. Water Flow Meters: Provide insertion type electromagnetic water flow meter as specified elsewhere in this section of the specifications.

J. Static Pressure Devices: Static pressure measuring stations with +/- 2% accuracy equal to Paragon Controls PE-5000 shall be provided. Industrial quality, electronic solid state, 1/2 percent accuracy static pressure transmitters equal to Paragon Controls Model DPT-4001 shall be provided. Transmitter span shall be matched to application.

K. Transformers: Provide all 24-volt control transformers necessary to convert 120-volt line voltage power to control voltage at control devices.

L. Relays, Hand-Off-Auto Switches, Pilot Lights: Provide all relays, hand-off-auto switches, and pilot lights necessary to accomplish automatic control of the mechanical systems. See electrical drawings for starters provided integral with hand-off-autos, pilot lights, and auxiliary contacts.

M. Pressure Switches: Pressure switches shall have contact action and pole configuration as required by application, U.L. listing, and adjustable setpoint.

N. Current Sensing Relays:

1. Acceptable Manufacturer: Hawkeye Model 908 or approved equivalent.

2. Current sensor shall be induce powered from the monitored load and shall have an adjustable operating range from 2.5 - 135 A. Visual indicators (LEDs) shall indicate output status and sensor power. Adjustable trip setpoint to +/- 1%. Current sensor output shall be N.O., solid state, 0.1A @ 30 VAC/DC.

O. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.

P. Carbon-Dioxide Sensor and Transmitters: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23 to 113 deg F, calibrated for 0 to 2 percent, with a continuous or averaged reading, 4-20 mA output, and duct mounted. Unit to be equal to Johnson Model CD-PRO-00-0 duct mounted CO2 transmitter. Provide unit with relay software kit (ACC-CD-S).

Q. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment, for flush mounting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Components:

1. Provide sensors, transmitters, controllers, actuators, valves, dampers, and related items, necessary to accomplish control sequence shown on drawings. Install all such devices except as noted herein to the contrary.

2. Deliver control valves to the job site to be installed by Mechanical Contractor under supervision of Controls Contractor.

3. Deliver automatic dampers to the job site to be installed by Mechanical Contractor under supervision of Controls Contractor.

4. Mechanical Contractor to install flow switches, immersion wells, pressure tapping, and all associated shut-off cocks required for control systems.

5. The control equipment and connecting piping shall be installed in a neat and workmanlike manner by trained mechanics in the direct employ of the control manufacturer.

6. All exposed tubing and conduit shall be run parallel to or at right angles to the building structure, and shall be concealed in all finished spaces. Tubing and conduit may be run exposed in mechanical rooms or areas where other piping is exposed.

7. Prepare coordinated composite wiring diagram showing all interlock wiring associated with starters, control panels, and controls.

8. Drawings and Layouts: The controls contractor shall provide to the mechanical contractor complete schematic drawings for the entire control system for submittal to the COTR for approval before work shall begin. Brochures describing each item of control equipment or component shall be included.

9. Provide sequence of operation.

10. As-built drawings to be framed under plexiglass and placed in each respective equipment room area.

B. Electrical:

1. Division 23 (Mechanical Contractor) shall furnish and install line- and low-voltage control wiring, including conduit, conductors, and terminations for same. Division 23 shall also furnish and install control components associated with the line- and low-voltage control systems and shall wire and connect components in accordance with approved wiring diagrams.

2. Division 26 (Electrical Contractor) shall furnish and install power wiring including conduit, conductors, and terminations to motors, safety switches, starters, relays, valve and damper actuators, and other components requiring power as indicated on the electrical drawings, by the specifications, and in accordance with approved wiring diagrams. Division 26 shall also furnish and install starters as scheduled on the electrical drawings.

3. Division 23 to furnish and install all local area network wiring, including conduit, conductors, and terminations for same. The local area network (LAN) shall be configurable as either a bus or a star, or a combination of the two. The LAN shall use twisted pair, coax, or fiber optic cable, or any combination of the three to meet noise immunity and/or distance requirements. The network design shall provide a high speed data transfer rate for alarm and report generation of no less than 100 Mb (Mb/s).

4. Division 23 to furnish all input and output control wiring, including conduit, conductors, and terminations for same. All input and output control wiring shall be #18 twisted and shielded cable. No input or output point shall be more than 250 feet from its respective panel. All shields to be grounded at the control panel. All shields at the sensors or transducers to be folded back and taped. All cable splices shall have joints soldered and taped including the shield. No mechanical connections will be acceptable. All connections within the panels must be made with connectors of appropriate size and design for the terminals being applied. All cables must be labeled and identified on corresponding termination drawings. A copy of the termination drawing shall be adequately protected and left in its respective panel.

5. Install all control wiring associated with DDC/BAS in minimum 1/2" size EMT. Provide all associated couplings, connectors, and fittings. No electrical wiring and polyethylene tubing may occupy the same conduit. Separate carriers are required.

6. All wiring shall be in accordance with local regulations and the National Electrical Code.

C. Room Devices:

1. Room devices shall be mounted so that the top of the device is 54" above the floor and aligned with the top of the light switch plates and 8" from the light switch if shown on the drawings adjacent to the light switch.

2. Room device locations shall be coordinated with door swings, light switches, and other wall-mounted items.

3.2 QUALITY CONTROL

A. Control system to be set up and checked out by factory-trained competent technician skilled in the setting and adjustment of temperature controls used in this project. This mechanic to be experienced in type systems associated with this control system. All control loops identified on the contract drawings shall be trended to verify proper control loop operation. Re-testing of deficient control loops shall be required until proper operation is obtained for a minimum of two (2) control cycles.

B. At time of final observation, Control Contractor to demonstrate the entire sequence of operation for the systems to the owner’s representative. At this time, owner’s representative to observe function of entire control system, observe temperature control operations, damper positions, necessary to assure that temperature control system is operating as intended by mechanical design.

C. Final acceptance of system not to occur until sequence of operation check and control loop operational verification has taken place and certified by owner's representative.

D. The Control Contractor is responsible for returning to job during the opposite season to verify operation of control system. The owner and the commissioning authority shall be given notice of this return and to accompany Control Contractor to observe the sequence of operation.

3.3 INSTRUCTION AND ADJUSTMENT

A. On completion of the job, the controls contractor shall have completely adjusted the entire control system. He shall arrange to instruct the COTR's representative on operation of the control system and supply him with three (3) copies of the control operating and instruction manuals.

B. Contractor Adjustment: The controls contractor must sign all prefunctional checklists that pertain to controlled equipment.

3.4 WARRANTY SERVICE

A. Warranty servicing shall be for a period not less than 12 months after final acceptance of the job by the COTR and include the following provisions:

1. Emergency maintenance service on regular working hour basis during warranty.

2. Replacing defective parts and components as required.

3. Servicing by factory trained and employed service representatives of system manufacturer.

4. Maintaining of system programming.

END OF SECTION 230900

SECTION 230923 - DIRECT DIGITAL CONTROL/UTILITY CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section applies to all Utility Control System instrumentation. Product quality, installation, and operation shall meet the requirements specified herein unless indicated otherwise on the design drawing(s).

B. The existing UCS architecture consists of multiple LAN segments supporting dual servers, operator workstations, printers and Ethernet to MS/TP data routers supporting multiple MS/TP LANs. The MS/TP networks include over 200 point-to-point modems and data converters used to extend each MS/TP LAN segment. Operator workstations are Windows XP based systems running Dorsett's Infoscan, Oracle Client, and other custom applications. Servers are Windows Server 2003 based systems running Dorsett Technologies Inc.'s Infoscan and Oracle Database Manager. The UCS monitors and/or controls more than 3.5 million square feet of conditioned space in excess of 100 buildings, comprising more than 18,000 connected field devices. Due to MSFC's multi-million dollar investment in the large installed UCS product base and to ensure 100% compatibility with the existing hardware and software, all construction, renovation or modification of facilities shall be an extension of the existing UCS architecture. For all modifications and/or additions that include UCS or affect UCS, the design of the UCS control system network and UCS equipment is done by a specialized "in-house" UCS design group at MSFC.

1.2 PRE-CONSTRUCTION MEETING

A. A control system pre-construction meeting shall be held prior to undertaking any control system construction installations at MSFC. The purpose of the meeting is to review this specification and discuss the project prior to starting work. Proper construction techniques and expected results will be discussed. In general, this meeting will address questions, or concerns, by any party, so that a clear understanding of the job scope and contractor responsibility is understood.

B. The contractor's construction supervisor or field manager must attend this meeting. The following individuals shall attend this meeting:

1. Project Manager/COTR
2. Construction Inspector
3. Utility Control System Representative
4. Utility Control System Designer
5. Contractor Construction Supervisor
6. Commissioning Authority

1.3 QUALITY ASSURANCE

A. The instrumentation installation shall be under the direct supervision of individuals with a minimum of 5-years experience in the installation and service of similar instrumentation.

1.4 RELATED SECTIONS

A. Section 23 09 00 “HVAC Instrumentation and Controls”, for non- DDC control system instrumentation.

B. Section 23 08 10 “Mechanical Systems Commissioning,” for controls contractor responsibilities in the commissioning process.

1.5 SYSTEM DESCRIPTION

A. A control system consists of sensors, indicators, final control elements, interface equipment, accessories, software, and other apparatus connected to distributed controllers operating in a multi-user, multitasking environment on Local Area Network(s), and programmed to control specified equipment.

1.6 SUBMITTALS

A. Product Data

1. Provide technical sheets on all system components shown on the design drawing(s).
2. Provide catalog cut-sheets, specifications, product data, warranty information and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents. A technical submittal must be submitted including specification compliance, technical sheets, and factory representative authorization. The technical submittal shall contain the following:
   a. Specification Compliance: The compliance document shall address each paragraph of the specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the proposed system.

B. Shop Drawings (Control Schematic Drawings)

1. The Contractor may not start work until the complete control schematic drawings of the entire control system are approved by the Government.
2. The control schematic drawings shall have a key to all abbreviations.
3. The control schematic drawings will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Communication trunk diagrams shall designate and identify the specific building location of each application specific or multi-function controller card and the relative position of each card on respective trunks.

5. The Contractor shall provide detailed I/O point summaries indicating each instrumentation point with wire termination identifications for each point and grouped by individual I/O card.
6. Provide a full points list with at least the following included for each point.
   a. Include:
      1) Control Points: Points that control equipment and can have setpoints changed (e.g., OSA, SAT)
      2) Intermediate Points: Points whose values are used to make calculations which then control equipment (e.g., space temperatures that are averaged to a virtual point to control reset).
      3) Calculated Points: "Virtual" points generated from calculations of other point values.
      4) Monitoring Points: Points that do not control or contribute to the control of equipment, but are used for operation, maintenance, or performance verification.
   b. Provide the following information for each point:
      1) Controlled system
      2) Point abbreviation
      3) Point description (e.g., DB temp, airflow)
      4) Setpoint

C. Sequences of Operation- The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:

1. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
2. All interactions and interlocks with other systems.
3. Detailed delineation of control between any packaged controls and the building automation system, listing what points the UCS monitors only and what UCS points are control points and are adjustable.
4. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
5. Start-up sequences.
6. Warm-up mode sequences.
7. Normal operating mode sequences.
8. Unoccupied mode sequences.
9. Shutdown sequences.
10. Capacity control sequences and equipment staging.
11. Temperature and pressure control: setbacks, setups, resets, etc.
12. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
13. Effects of power or equipment failure with all standby component functions.
14. Sequences for all alarms and emergency shut downs.
15. Seasonal operational differences and recommendations.
16. 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.
17. Schedules, if known.

18. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

D. As-Builts

1. Provide one hardcopy and compact disc (CD) in either Bentley Systems' Microstation or DXF format and shall include Contractor's original, untranslated drawing file. The as-builts shall include:
   a. Wiring diagrams
   b. System schematics
   c. Communication trunk layout

E. Test Plans, Trends, and Test Reports

1. Thirty days prior to the start of system verification, three (3) copies of written test plans describing control system verification and operational functionality procedures shall be submitted for Government approval. The Contractor is responsible for the development of the test plans. Test plans shall validate the intended purpose and operational effectiveness of the entire system; this includes all hardware devices and software sequences called for on the design drawings.
2. Control system verification procedures describing how the operation of each control loop will be verified shall be submitted by control loop, identifying each sensor, actuator, controller, transducer, and measuring device, as required. The procedures shall describe adjustments in terms of control component positions, input and output signals and ranges, air and water flow rates, temperature and humidity setpoints, calibration of valve and damper actuators and sensors, and all other pertinent control parameters. Submit bound copies of individual trend data, with table of contents, for each control loop identified on the contract drawings for verification of proper control loop operation, at least 30 days before Functional Performance Testing begins. Functional Performance Testing scheduled start date shall be obtained from the MSFC Commissioning Agent. Trend data shall identify that HVAC system that the control loop is installed in, control loop description (e.g., cooling coil control loop), control component designation (e.g., CCSAT-1, CHWV-1), and controlled component value or position for the duration of the control action. Trend data shall be provided for a minimum of two (2) control cycles to verify proper loop control operation.
3. Local Server control system verification test reports describing test results of each control loop shall be submitted in bound form and shall indicate the final values and settings of each control component in each control loop. Where testing indicates a necessary deviation from the contract drawing sequences of operation and controls submittals, the Government shall be informed immediately. Any deviations shall be made only after Government approval and the test report shall note any changes in the control loop or component settings caused by the deviation. Seven (7) hardcopies and two (2) electronic copies on CD of the control system verification test report shall be submitted within 30 days after completion of testing.
4. MSFC/BASSCO Server control system verification test reports describing test results of each control loop shall be submitted in bound form and shall indicate the final values and settings of each control component in each control loop. Seven (7) hardcopies and two (2) electronic copies on CD of the control system verification test report shall be submitted within 30 days after completion of testing.

F. Manufacturer’s Instructions: Contractor shall submit three (3) hardcopies and three (3) electronic copies on CD of manufacturer’s instructions describing installation of a product or system, special notices and material safety data sheets concerning impediment, hazards, safety precautions, startup, shutdown, and emergency operation.

G. Operation and Maintenance Manuals: Operation and maintenance manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Contractor shall submit three (3) hardcopies and three (3) electronic copies on CD of O&M documentation. Operation and maintenance manuals shall be provided for all control system instrumentation products.

H. Qualification Data: The contractor shall submit a list of personnel qualifications, projects, dates, and control descriptions of installed systems as proof of experience installing similar instrumentation.

I. Course content and format of training materials.

1.7 TELECOMMUNICATIONS

A. Telecommunication lines are furnished by the Government. If installation of a communication line to a new field interface device is specified on the design drawing(s), the Contractor shall submit a written request to the BASSCO Contractor 30 days prior to system startup.

B. The Contractor shall furnish the modems specified below or approved equal for installation as required on contract drawings.

1. Patton Electronics Co.
2. ADC-MegaBit
3. Rack-mount modem:
   a. Patton Electronics P/N 1080ARC
4. Stand-alone modem:
   a. Patton Electronics P/N 1080
   b. ADC-MegaBit DSL P/N MM702G

PART 2 - PRODUCTS

2.1 The Controls Contractor shall furnish components required by design and described herein.

2.2 DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

A. Utility Control System (UCS): This work includes all material, equipment, and appurtenant accessories necessary for, or incidental to, the installation of a complete Direct Digital Control (DDC) System as specified in the design package. The appropriately selected DDC configuration shall be capable of controlling processes in the building through configurable electronic controllers. This configurable hardware shall be electronically interfaced via an Interface Card (CPU), X-Talk or UNV-T-E card, manufactured by Dorsett Technologies Inc., http://www.dorsett-tech.com/, through telecommunication data lines to the central computer-

based Utility Control System (UCS) located in Room 29 of Building 4250. Complete operational compatibility shall be maintained between the central UCS Infoscan system, both hardware and software, as manufactured by Dorsett Technologies Inc. and the direct digital controllers. The central host computer communicates via Government-furnished telecommunication lines and contractor installed modems to Dorsett's Interface Panel(s) located in the building(s) where the project is being performed. The Interface Panel communicates with application-specific controllers or multi-function controller cards, which implement direct control of equipment through industry standard electronic signals.

B. DDC hardware and software will communicate directly with the central host Infoscan application and that all existing UCS programs will function completely to control and monitor related equipment. It also means that engineering units, values, or parameters utilized within the panels or controllers are compatible with units used within the Infoscan System. The field hardware and the central host computer shall communicate and be fully programmable from the host Infoscan application.

C. Operators shall have the ability to specify within the software and in standard engineering units the amount by which the point must change at the sensor before it is reported as changed to the UCS central servers in Building 4250. This feature provides a system function referred to as "report-by-exception."Interface cards only report to the central computers value changes that exceed the selected delta value. This minimizes data traffic on telecommunication lines to and from the UCS central servers.

D. Each point that is used within the process shall be displayable and accessible through an Infoscan point review. When these points are represented as displayed values on computer graphic displays, operators shall be able to select these values with a point device and retrieve accurate data within 20 seconds.

E. Computer graphic displays shall be developed to represent each HVAC or environmental control component or system. These pictorial displays shall represent a chiller with all support pumps, valves, towers, air handlers, etc. All related analog and status points shall be dynamically represented on the display. If an analog or binary point changes value beyond the delta limit, this condition must be reported to an operator workstation within 20 seconds.

F. The Contractor shall perform all application programming and point configurations through existing operator workstations via Infoscan software. All programming and graphic display generation for a completely operational system shall be provided.

G. Field Interface Device: A Field Interface Device, also called FID, SID, MID, JID, etc., is a solid state electronic device with supporting software that provides an interface and permits communication between field controllers and the UCS servers. This device is the Dorsett's CPU card, X-Talk or UNV-T-E card into which the multifunction or application-specific cards are interfaced. It is connected via Government-furnished telecommunication lines to the UCS central servers in Building 4250. It has hardware and software compatibility with the existing Utility Control System. This card functions on a "report-by-exception" basis as described earlier in this section. If a new Interface Device is required, it shall be acquired from Dorsett Technologies Inc.

H. Multi-Function Controller Card: Is a solid-state electronic controller with universal input-output channels. All configuration parameters are fully programmable via the UCS central servers. Multifunction controller cards are manufactured by Dorsett Technologies Inc. include:

1. MS4-UNV-T-E
2. MS4 xTalk
3. SCADA Controller
4. MS3 Controller Cards

I. Application-Specific Controller: An application-specific controller cards shall be connected and communicate to the UCS system through the CPU, UNV-T-E cards, or X-Talk. An example is an MS4-VAV controller.

J. Equipment Specific Controller (ESC): An equipment specific controller is any controller that is user programmable such as programmable logic controllers (PLC), PID controllers, etc. An ESC, when allowed by contract drawings and specifications, shall have all pertinent accessories included for the programming, downloading, and documentation of software. When available the contractor shall provide a Government approved programming device including software, cables, hardware locks, etc. to provide for the physical connection to the ESC and access to the non- volatile memory for programming of the ESC. Programming software shall be provided on factory media with all/any serial numbers, key codes, etc. such that the media can be registered with the manufacturer. For all ESC's, the contractor shall provide two (2) hardcopies of the factory programmed software logic. Owner's manuals and programming manuals shall also be included with all ESC installations. Where UCS control is desired, ESC's must be compatible with accepted UCS communication protocols. Examples of these protocols are:

1. BACnet – IP
2. BACnet – MSTP
3. N2 – (Johnson Controls Inc.)
4. Modbus RTU.

K. Control Panel (MUX):

1. A control panel is a completely configured field panel consisting of multi-function controller card(s), power supply(s), and terminal strips, fully contained within a UL listed, NEMA rated enclosure. Control panels manufactured by Dorsett Technologies Inc., are available in several sizes and configurations.
2. All control panels shall have a trough wire-way mounted above and below the enclosure for conduits to enter or exit. Chase nipples or conduits shall be used to connect the trough to the bottom of the control panel enclosure. Only penetrations in the bottom of the UCS control panel shall be made.

2.3 FIELD DEVICES

A. General:

1. The use of interface signal converters is not allowed unless otherwise indicated on design drawings.
2. 24 volt AC power sources shall be 120 volt AC primary input, 4 amp minimum rated secondary, on/off switch, circuit breaker mounted in metal enclosure.
3. Uninterruptible Power Sources (UPS) shall have user accessible batteries, automatic voltage regulation and 1 KVA minimum capacity rating.
4. Acceptable industry standard analog voltage and current signals are as follows: 4 to 20mA, 0 to 20mA, 0 to 10VDC and 2 to 10VDC.

B. Temperature Sensor: Temperature sensors shall be 100 Ohm or 1000 Ohm 0.00385 coefficient platinum Resistive Temperature Devices (RTD). All temperature transmitters shall be provided as specified on the design drawings. Temperature sensors shall conform to DIN-IEC-751 class B (+/- 0.12%). As minimum requirements, the repeatability shall be +/- 0.1 degrees C and the stability shall be less then +/- 0.1 degree C drift per year. The transmitter shall be 4-20 mA loop powered having a calibration accuracy of +/- .1% of span and a linearity of 0.1% of span, unless otherwise specified.

1. Duct Temperature Sensor: Probe sensors for supply air and return air shall have rigid averaging elements and be installed horizontally extending two-thirds of the duct width as a minimum. Probe to four times duct width. Non-platinum 0.00385 coefficient RTD's having platinum equivalent accuracy may be used.
2. Room Temperature Sensor: Room sensors shall be provided with a high impact plastic cover. When connected to an application-specific controller the sensor shall include an access-port for communications.
3. Immersion Well Temperature Sensor: Immersion sensors with thermowells shall be installed in liquid applications. Thermowells shall be stainless steel.

C. Pressure Sensor

1. Static Air Pressure Sensor: Pressure sensors shall be 4 to 20 milliamp, loop powered, 1/8-inch brass barb fittings and 1% full-scale accuracy. Static pressure sensors shall have a range approximately twice the setpoint called for in the sequence of operation. Duct static pressure sensors must be located downstream of fan 2/3 of the duct length.
2. Liquid and Gas Pressure Sensor: Pressure sensors shall be Setra Model 256 or approved equal. Isolation valves shall be installed on each device port to facilitate removal/replacement.
3. Liquid and Gas Differential Pressure Sensor: Differential Pressure sensors used for gas and liquid applications shall be Setra Model 230 or approved equal. Isolation valves shall be installed on each device port to facilitate removal/replacement.
4. Low Differential Air Pressure Sensor: Pressure sensor shall be Setra Model 267 or approved equal.
5. Space Air Pressure Sensor: Space air pressure sensors shall be bi-directional, 4 to 20 milliamp loop powered unless otherwise specified.

D. Humidity Sensor Relative Humidity Sensor: Humidity sensors shall be plus or minus 3 percent minimum accuracy, unless otherwise specified. Sensor output signal shall be loop powered 4 to 20 milliamps. Humidity sensor shall be Vaisala Model HM40 series.

E. Pressure Switch

1. Air Differential Pressure Switch: Differential pressure switches for airflow confirmation shall be Dwyer Instruments Model 1910 series or approved equal.
2. Liquid Differential Pressure Switch: Differential pressure switches for proving water flow shall be Penn Model P74FA-5 or approved equal. Isolation valves shall be installed on each device port to facilitate removal/replacement.

F. Actuators: Electronic actuators shall be 24 VAC powered, unless otherwise specified and operated by industry standard process signals. Examples are 4 to 20mA, 0 to 10V, Pulse-Width Modulation and 3- Point Floating.

G. Enclosures: Enclosures shall be UL listed, constructed of minimum 14 gauge sheet metal with spot welded joints, gray enamel finish and suitable for the application. Doors shall have a left-hand hinge and slotted-head screw operated latch.

H. Utilities Metering: All programmable utility meters as required on contract drawings shall have all pertinent accessories included for the programming, downloading, and documentation of software. When available the contractor shall provide a Government approved programming device including software, cables, hardware locks, etc. to provide for the physical connection to the meter and access to the nonvolatile memory for programming of the meter. For all programmable meters, the contractor shall provide two (2) hardcopies of the factory programmed software logic. Owner's manual and programming manual shall also be included with all installations.

I. Where discrete connections are specified, meter output(s) shall be directly connected to the Utility Control System DDC hardware. Meter electrical ratings shall be compatible with the Utility Control System DDC hardware. Pulse outputs shall indicate an accumulated quantity. Minimum pulse output duration shall be 0.25 seconds. Pulse output type shall be open-collector/current sinking or form C relay contacts. If specified on the contract drawings, the following utility meter to UCS connections may be required:

1. Pulse output meters:
   a. Industrial water
   b. Potable water
   c. Natural gas
2. Analog output rate meters:
   a. Chilled water flow
   b. Hot water flow
   c. Process flow
3. Interface Communicating output meters:
   a. Electrical power
   b. BTU

J. Voltage/Phase-loss monitor: Device shall be plug-in style selected per application; automatic reset type with DPDT form C relay outputs, adjustable trip setpoint.

K. Indoor Air Quality (IAQ): Device shall have an analog output corresponding to Carbon Dioxide (CO2) concentrations ranging from 0 to 2000 ppm.

L. Gas Detection: Gas detection devices, e.g. Oxygen Deficiency, Hydrogen, Fluorine and Carbon Monoxide shall have form C relay alarm output(s).

M. Current Switch: Device shall be capable of switching 150mA continuously. Split core design with adjustable trip point and capable of switching AC or DC circuits. Applicable for VFD applications down to 6Hz and powered by monitored line.

N. Water Level Detection: Device shall have 4 – 20mA output.

O. Moisture Leak Detection: Device shall provide the following features:

1. By-zone form C relay interface capable of 32 alarm outputs
2. ALARM, FAULT, and HORN form C relay outputs

3. 36 hour battery backup
4. Capable of monitoring 32 independent zones
5. Provides subsequent alarming, no matter how many zones go into ALARM or FAULT
6. Identifies location, time & date of all ALARM and FAULT conditions displayed in chronological order via a LCD alphanumeric display
7. ALARM, FAULT and POWER front-panel mounted LED Indicators
8. Lineal leak detection tape

P. Variable Frequency Drive: VFD shall have an analog 0-20mA, 0- 10VDC, 2-10VDC, 4 – 20mA input for speed control, a contact closure input for start/stop control, and N2 communications.

2.4 LABELING

A. Sensor and Control Devices: Each sensor and each control device shall be labeled at the sensor or device with the Infoscan database point name that identifies it. The point name shall be displayed in print achieved electronically or typographically on permanent adhesive labels. Minimum label size shall be 1 inch by 1/2 inch. Label color shall be white background. Printed text shall be black.

B. Enclosures: UCS control panels, as a minimum, shall be labeled. Labels shall be engraved plastic, beveled edges, black background, white letters. Letter height shall be 1/2 inches minimum. Overall label dimensions shall be 1.25 inches minimum height, length as required. Labels shall be centered along width and located within upper 1/4 area of enclosure door. Minimum distance from top of enclosure shall be 3 inches. Labels shall be affixed with adhesive cement. Panels shall be labeled consistent with design drawing terminology.

C. Terminations: Each terminated wire shall be clearly labeled with Field Device Infoscan point name (example AH1-SAF) at the Field Device and at each wire termination. Labeling shall display device or point names and shall be displayed in print achieved electronically or typographically. The Government shall approve labeling medium and method before work begins. Label shall be Brady model WMS-117- 319 or approved equal.

2.5 WIRING

A. Instrumentation/ Low Voltage and Data Communications Cable Wiring: All wiring shall be installed in dedicated conduit with the exception of plenum-rated wire which may be used in runs in concealed but accessible ceiling areas and computer room sub-floor only. A.C. power wiring greater than 24V shall not be installed in the same conduit, or pathway, with low voltage (24 volt or less) wiring. Conduit shall be 3/4 inches minimum diameter. Flexible conduit shall not exceed 3 feet in length and shall be ½ inch minimum in diameter. Wiring specifications are as follows:

B. Instrumentation/ Low Voltage Wiring:

1. 1-Pair, 22 AWG, stranded (7X30), twisted pair construction, 300 volt, polymer alloy-insulation, maximum O.D. of 0.15 inches, aluminum foil-polyester tape 100% shield, 24 AWG stranded drain wire, and plenum rated-jacket. Gray jacket with one black and one red wire. West Penn part #25291B or approved equal.

2. 2-Pair, 22 AWG, stranded (7X30) twisted pair construction 300, volt, polymer alloy-insulation, maximum O.D. of 0.21 inches, individual aluminum foil-polyester tape shielded pairs, 100% shield coverage, 24 AWG stranded (7X32) tinned copper drain wire, and plenum rated-jacket. Gray jacket with black/red and white/green wire pairs. West Penn part #25510B or approved equal.
3. Control Panel Instrumentation/ Low Voltage Wiring shall have shield/drain wires terminated only at a grounding bar in the wire trough located beneath the MUX panel. A 25 position (minimum) grounding bar shall be mounted and bonded to the wire trough bottom. A maximum of five shield/drain wires shall be terminated at each ground bar position. Shield/drain wires are not permitted in the control panel and shall remain within the wire trough enclosure.

C. Instrumentation/ Low Voltage Wires connecting field devices shall not be spliced or butted together. They shall be "home runs" from the field device to the panel.

D. Data Communications Cable Wiring:

1. 1-Pair, 24 AWG, stranded (7X32), characteristic impedance 120ohms, twisted pair construction, 300V, Foamed Teflon insulation, maximum cable diameter 0.202 inches, aluminum polyester foil 100% shield, 24 AWG stranded tinned copper drain wire, and plenum PVC rated-jacket. Gray jacket with one white/blue wire West Penn part #D254851, Belden part# 82841 or approved equal.

E. Data Communications Cable Conductors: The stripped portion of the stranded data communications cable shall be no more than 3 inches in length.

F. Data Communications Cable Shield/Drain Wire: Data Cable shall have shield/drain wire terminated only at the point of origin to the communication ground. The cable section where the stripped portion ends and the wire jacket begins shall be covered with heat shrinkable tubing. The drain wire length shall be kept to a minimum. The end point of the daisy chain configuration, at the last device, the shield/drain wire shall be cut and covered by heat shrinkable tubing. At connection points on the daisy chain configuration other than the origin or end shield/drain wires shall be connected via but-splice or soldered connection, so that the shield/drain wires are continuous throughout. Shield/drain wires shall not come into contact with any metal surface other than the points of termination.

G. Data Communications Cable Terminators: Each terminator shall be fabricated using 22/24 GA. Stranded lead wire soldered to the termination resistor leads. The lead wire shall be approximately 2 inches in length. The termination resistor and soldered connections shall be covered with heat shrinkable tubing. The termination resistors shall be 120 ohm resistors with 1% tolerance and ¼ watt minimum. A terminator is required, at the endpoints of the daisy chain configuration, on the data communications cable. One terminator shall be located at the point of origin which is the beginning of the data circuit. The other terminator shall be located at the last device in the data circuit /end of line.

H. 24 VOLT POWER WIRING: 2 Conductor, 16 AWG, stranded (19X29) wire for delivering low voltage power to 24 volt UCS connected devices. Plenum rated-jacket, 300 volt, polymer alloy insulation and maximum O.D. of 0.18 inches. Gray jacket with one black and one red-wire. West Penn part #25225B-or approved equal.

2.6 COMMUNICATING/ INTERFACING

A. Equipment described in this section shall interface to the existing InfoScan system using standard interface protocols as shown on contract drawings. Typical industry standard interfaces are Johnson N2, Modbus RTU, BACnet-MSTP and BACnet-IP.

B. The following categories list the minimum required interface protocol read/write properties:

1. Hot Water Boiler Requirements
   a. Read Properties:
      1) Boiler Run Status
      2) Low water
      3) High water
      4) Water Supply Temperature
      5) Water Return Temperature
      6) Boiler Alarm
      7) Stack Temperature (fuel-fired only)
   b. Write Properties:
      1) Leaving/Return Water Temperature Setpoint
      2) Boiler Enable
      3) Boiler Disable

C. Variable Frequency Drive Requirements

1. Read Properties:
   a. Frequency
   b. Power
   c. Motor Current
   d. Runtime
   e. Fault Alarm
2. Write Properties:
   a. Start
   b. Stop
   c. Frequency Setpoint
   d. Minimum Frequency
   e. Maximum Frequency
   f. Ramp Time
   g. Max Current
   h. Max Torque

D. Electrical Meter Requirements

1. Read Properties:
   a. KW*
   b. KW (demand)*
   c. KWH
   d. Amps*
   e. Volts*
   f. Neutral Amps*
   g. Power Factor*
   h. THD*

i. KVA*
j. KVAR*
k. KVARHR
l. Demand Reset
m. Power Fail Alarm
*Include Min/Max parameters

2. Write Properties
   a. Demand Period
   b. Number of Demand Periods
   c. Reset KWH
   d. Reset KVARHR
   e. Reset Min/Max Values

E. BTU Meter Requirements

1. Read Properties:
   a. Water Flow Rate
   b. Water Supply Temperature
   c. Water Return Temperature
   d. BTU Rate
   e. BTU Total
2. Write Properties:
   a. Reset BTU Total

F. Water Meter

1. Read Properties
   a. Total
   b. Rate
2. Write Properties
   a. Reset Total

PART 3 - EXECUTION

3.1 GENERAL

A. All products shall be installed in accordance with manufacturer's instructions. Installation of control components shall be performed by qualified control and instrumentation specialists. Only penetrations in the bottom of enclosures shall be made unless otherwise specified on contract drawings.

3.2 SERVER

A. The contractor shall host the server function of the UCS system at the building locally. The local server will be utilized through all testing and check out phases, including commissioning.

B. Upon completion of commissioning activities, the contractor will turn over the programming and database information to the MSFC/BASSCO contractor and assist in integrating the software into the MSFC/BASSCO servers.

C. After the software transfer is completed, the system shall be tested per the requirements in paragraph 3.9.E.

3.3 AC POWER WIRING

A. The Contractor shall install 120 Volt AC power wiring for control system instrumentation if required by device. The breaker must be dedicated to the device and labeled. All work shall be performed in accordance with applicable sections of Division 26, "Electrical," unless otherwise specified. Contact the COTR before performing any electrical panel modification.

B. The UCS control panel Uninterruptible Power Source (UPS) input voltage shall be supplied by dedicated 120 volt AC duplex receptacle.

C. 120 volt AC input power cord for field panels shall be of sufficient length to allow connection to either UPS output receptacle or 120 volt AC duplex receptacle dedicated for UPS input.

D. A power disconnect switch shall be provided at each VAV used in the control system and located on the high voltage side of the control transformer.

3.4 EQUIPMENT ACCESSIBILITY

A. Enclosures: Enclosures shall be installed in accordance with the National Electrical Code as a minimum standard. Doors shall not be obstructed and shall open a minimum of 90 degrees from its closed position.

B. Instrumentation: All control system instrumentation shall be installed such that each device is accessible and unobstructed to facilitate ease of maintenance. Examples of obstructed equipment typically include piping surrounding valve actuators and covers that protect electronic components in VAV applications.

3.5 VIBRATION ISOLATION

A. Controllers and other devices sensitive to vibration shall be isolated by location or utilizing shock absorbing mounting devices.

3.6 SEQUENCE OF OPERATION

A. The sequence of operation shall be as indicated on the design drawing(s). All changes to the Sequence of Operation shall be noted on the as-built drawings.

3.7 CONTROL SYSTEM DRAWINGS

A. At completion of the job, the Contractor shall furnish copies of as-built wiring diagrams, system schematics, and sequences of control. One (1) copy of each shall be enclosed in laminated plastic, suspended at each air handler and/or controlled system and inside each control panel, or as directed by the Contracting Officer's Technical Representative (COTR).

B. Wiring diagrams shall show all instrumentation, interlocks and connection information required for controlling the specified equipment.

3.8 SYSTEM GRAPHICS

A. The controls contractor shall provide graphics to include dynamic point summary tables for like systems, schematics with dynamic points for all systems to be controlled, and a summary table for building information to I include all utility meters, pressures, outdoor conditions.

B. Before graphics are programmed and installed, a meeting shall be held with MSFC/BASSCO personnel and the COTR. The meeting will coordinate between the existing UCS graphics and the new “to be programmed” graphics. This will ensure that graphics are consistent between the existing and new screens.

C. Building floor plans will be programmed in graphic format by MSFC and is not in this contract.

3.9 SYSTEM VERIFICATION AND STARTUP

A. Verification testing shall be performed in the presence of the Government Construction Management Inspector (or CA in the case of commissioned equipment) and shall be repeated, as necessary, until each system or control loop is successfully verified.

B. The Contractor shall have factory-authorized representatives perform system start-up and adjustment after acceptance of test plans.

C. The Contractor shall demonstrate to the Government through a system verification test that final calibrations and adjustments are accurate and each control loop operates as defined by the sequence of operation. All deficiencies shall be corrected prior to final acceptance. The Government Construction Management Inspector (or CA in the case of commissioned equipment) shall witness all verification tests.

D. The Controls Contractor shall perform a complete checkout and verification of the controls and instrumentation before total system commissioning begins. The Controls Contractor shall participate in the total integrated system commissioning. Integrated system commissioning procedures are specified in Section 01 91 13, “General Commissioning Requirements.”

E. After the software transfer from the local server to the MSFC/BASSCO server is completed, the system shall be retested per the following. 10% of each type of control loop shall be retested, checked, and compared with the trends from the local server function. If one control loop is found to not function in the same manner, the loop shall be reprogrammed and tuned to the correct function and 50% of each type of control loop shall be tested. If One control loop (out of the 50%) is found to not function in the same manner, the loop shall be reprogrammed and

tuned to the correct function and 100% of all control loops shall be tested and any deficiencies corrected.

3.10 TRAINING

A. The Contractor shall provide 2 identical complete on-site instruction Session(s) for approximately 10 personnel. Each session shall consist of a minimum of 8 hours. Instructors shall be factory-authorized representatives. The government shall approve course content and format.

END OF SECTION 230923

SECTION 231123 - FACILITY NATURAL-GAS PIPING

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.
5. Pressure regulators.

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.
2. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.

2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.

1.6 INFORMATIONAL SUBMITTALS

A. Welding Procedures Specifications.

B. Welding Procedural Qualifications Records.

C. Welder’s Qualifications Reports

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.8 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.

1.9 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.

1.10 PROJECT CONDITIONS

A. 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 Government no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Government's written permission.

1.11 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Operating-Pressure Rating: 0.5 psig.
3. End Fittings: Zinc-coated steel.
4. Threaded Ends: Comply with ASME B1.20.1.
5. Maximum Length: 24 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. 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" Articles 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 "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
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. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "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.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

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. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Canadian Meter Company Inc.
   b. Eaton Corporation; Controls Div.
   c. Harper Wyman Co.
   d. Maxitrol Company.
   e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

2.6 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, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

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.

2.7 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 natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. 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.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. 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.

P. 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.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. 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.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

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.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. 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.

C. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.7 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. 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.

D. 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 230553 "Identification for HVAC Piping and Equipment" 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. Paint exposed, exterior 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. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (flat).
d. Color: Gray.

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: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (flat).
d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (flat).
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 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall bethe following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall bethe following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Bronze plug valve.

C. Valves in branch piping for single appliance shall be the following:

1. Bronze plug valve.

END OF SECTION 231123

SECTION 232113 - HYDRONIC PIPING

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 pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Air-vent piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure-seal fittings.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Procedures Specifications.

B. Welding Procedures Qualification Records.

C. Welder’s Qualification Reports

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 125 psig> at 200 deg F.
2. Chilled-Water Piping: 125 psig> at 200 deg F.
3. Condensate-Drain Piping: 150 deg F.
4. Air-Vent Piping: 200 deg F.
5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

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, provide products by one of the following:

   a. Jomar International, Ltd.
   b. Matco-Norca.
   c. Watts Regulator Co.
   d. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

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, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Matco-Norca.
   c. Watts Regulator Co.
   d. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

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 Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elster Perfection.
   b. Grinnell Mechanical Products.
   c. Matco-Norca.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.

2. Description:

   a. Standard: IAPMO PS 66.
   b. Electroplated steel nipple, complying with ASTM F 1545.
   c. Pressure Rating: 300 psig at 225 deg F.
   d. End Connections: Male threaded or grooved.

e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40, Grade B, Type 96 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

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 special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.
4. Air-vent piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 125 psig at 200 deg F (93 deg C).
2. Chilled-Water Piping: 125 psig at 200 deg F (93 deg C).
3. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
4. Condensate-Drain Piping: 150 deg F (66 deg C).
5. Air-Vent Piping: 200 deg F (93 deg C).
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."Section 15900 "HVAC Instrumentation and Controls."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump.
c. Flow Design Inc.
d. Griswold Controls.
e. Taco.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Brass, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flow Design Inc.
b. Griswold Controls.
c. Nexus Valve, Inc.

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig (1207 kPa).
9. Maximum Operating Temperature: 200 deg F (93 deg C).

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Nexus Valve, Inc.
e. Taco, Inc.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/8 (DN 6).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 225 deg F (107 deg C).

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Nexus Valve, Inc.
   e. Taco, Inc.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/4 (DN 8).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 240 deg F (116 deg C).

C. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.

b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Taco, Inc.

2. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

E. Air Purgers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Taco, Inc.

2. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
3. Maximum Working Pressure: 150 psig (1035 kPa).
4. Maximum Operating Temperature: 250 deg F (121 deg C).

2.4 HYDRONIC 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 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."Section 15124 "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

F. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

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. Close-coupled, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. ITT Corporation; Bell & Gossett.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed and rigidly mounted to pump casing with integral pump support.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Enclosure: Open, dripproof.
b. Enclosure Materials: Cast iron.
c. Motor Bearings: Permanently lubricated ball bearings.
d. Unusual Service Conditions:

e. Efficiency: Premium efficient.

E. Capacities and Characteristics (See Drawings):

2.2 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with"ANSI/HI 1.4-2010", American National Standard for Rotodynamic (Centrifugal) Pumps.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548.13 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install triple-duty valve on discharge side of pumps.

E. Install suction diffuser and shutoff valve on suction side of pumps.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

H. Install check valve and gate or ball valve on each condensate pump unit discharge.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. The Contractor shall follow and shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article. SMACNA Guidelines for design of bracing and reinforcements will be provided by the Contractor.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.

2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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. Lindab Inc.
   b. McGill AirFlow LLC.

c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner 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. CertainTeed Corporation; Insulation Group.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Owens Corning.
    e. Maximum Thermal Conductivity:

        1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
        2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

    a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.

b. Intervals of lined duct preceding unlined duct.
c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. FIELD QUALITY CONTROL

B. Perform tests and inspections.

C. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

   a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

D. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

E. Duct system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round: 12.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

   a. Pressure Class: Positive 4-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

4. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

B. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.

c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 1-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:

a. Type 316, stainless-steel sheet.

1) Exposed to View: No. 4 finish.
2) Concealed: No. 2B finish.

b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
c. Pressure Class: Positive or negative 3-inch wg.
d. Minimum SMACNA Seal Class: A.
e. SMACNA Leakage Class: 3.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round: 6.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 3-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.

c. SMACNA Leakage Class for Rectangular: 3.
d. SMACNA Leakage Class for Round: 3.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

F. Liner: (Sound Trap Service Only)

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch thick.
3. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

b. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT 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. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Flange connectors.
6. Duct silencers.
7. Turning vanes.
8. Remote damper operators.
9. Duct-mounted access doors.
10. Flexible connectors.
11. Flexible ducts.
12. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and and exposed ducts.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 1000 fpm .

D. Maximum System Pressure: 1-inch wg.

E. Frame: Hat-shaped, 0.05-inch- thick, galvanized sheet steel, with welded corners or mechanically attached.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Felt.

I. Blade Axles:

1. Material: Nonferrous metal.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. Nailor Industries Inc.
c. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. McGill AirFlow LLC.
c. Nailor Industries Inc.
d. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:

a. Hat shaped.
b. 0.094-inch- thick, galvanized sheet steel.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

a. Multiple or single blade.
b. Opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized, roll-formed steel, 0.064 inch thick.

7. Blade Axles: Galvanized steel.
8. Bearings:

a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Felt.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.

12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. McGill AirFlow LLC.
3. Nailor Industries Inc.
4. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.
2. 0.094-inch- thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch thick single skin.
5. Blade Edging: PVC.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cesco Products; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.7 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Elgen Manufacturing.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single or Double wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cesco Products; a division of Mestek, Inc.
2. Ductmate Industries, Inc.
3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan as indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. At outdoor-air intakes and mixed-air plenums.
3. At drain pans and seals.
4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
5. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
6. At each change in direction and at maximum 50-foot spacing.
7. Upstream from turning vanes.
8. Control devices requiring inspection.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with adhesive draw bands.

Q. Install duct test holes where required for testing and balancing purposes.

R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233416 - CENTRIFUGAL HVAC FANS

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: For each product.

1. Backward-inclined centrifugal fans.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

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. Capacities and Characteristics (See Drawings):

1. Vibration Isolators: Spring isolators having a static deflection of 1 inch.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Mfg. Corp.
2. Greenheck.
3. Loren Cook Company.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Backward-Inclined Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours.

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.

9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548.13 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install units with clearances for service and maintenance.

F. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to 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:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416

SECTION 233433 - AIR CURTAINS

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 air curtains.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties, and accessories.

B. Shop Drawings: For air curtains. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Warranties: Sample of special warranties.

B. Source Quality-Control Reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air curtains to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish one set of filters.
2. Furnish one set of fan belts for each unit.

1.7 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 AMCA 220, "Laboratory Methods of Testing Air Curtains for Aerodynamic Performance Ratings," for airflow, outlet velocity, and power consumption.

C. Comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.

1. Certify coils according to ARI 410.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air curtains that fail in materials or workmanship within specified warranty period.

1. Warranty Period (Nonheating Units): 24 months.

PART 2 - PRODUCTS

2.1 AIR-CURTAIN UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Economy Corporation; a division of Scott Springfield Manufacturing, Inc.
2. Fantech.
3. Loren Cook Company.
4. Marley Engineered Products.
5. Mars Air Products; Mars Air Door Division.
6. Mestek, Inc.; L. J. Wing Division.

B. Housing:

1. Materials: Galvanized steel with electrostatically-applied epoxy-enamel finish over powdered mirror.
2. Materials: Heavy-gage, electroplated-zinc steel with welded construction and polyester-coated finish.

C. Mounting Brackets: Steel, for ceiling mounting.

D. Air-Intake Grille:

1. Grille: Integral part of and same material as the housing.
2. Insect Screen: Aluminum, removable.

E. Fans:

1. Centrifugal, forward curved, double width, double inlet.
2. Galvanized steel.
3. Statically and dynamically balanced.
4. Direct drive.

F. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Single speed.
3. Resiliently mounted.
4. Continuous duty.
5. Totally enclosed, air over.
6. Integral thermal-overload protection.
7. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
8. Disconnect: Internal power cord with plug and receptacle.

G. Filters:

1. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with glass-fiber media sprayed with nonflammable adhesive in galvanized-steel frame.
2. Washable Panel Filters: Removable, stainless-steel, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch- thick, stainless-steel filter frame.
3. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

H. Controls:

1. Built-in Thermostat: Line voltage, factory installed and wired to the junction box on air curtain.
2. Automatic Door Switch: Roller type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
3. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.
4. Three-Speed Switch: Manually activates, deactivates, and controls air-curtain fan speed.
5. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.
6. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 1 enclosure with door-mounted hands-off-auto switch.

I. Accessories:

1. Mounting Brackets: Adjustable mounting brackets for drum-type roll-up doors.
2. Discharge Extension Neck: For ceiling-recessed installation.

J. Capacities and Characteristics (See Drawings):

a. Electrical Characteristics (See Drawings):

2.2 SOURCE QUALITY CONTROL

A. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install air curtains with clearance for equipment service and maintenance.

B. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing air curtains completely, perform visual and mechanical check of individual components.
2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-curtain unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust belt tension.

B. Adjust motor and fan speed to achieve specified airflow.

C. Adjust discharge louver and dampers to regulate airflow.

D. Adjust air-directional vanes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air curtains.

END OF SECTION 233433

SECTION 233600 - AIR TERMINAL UNITS

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. Shutoff, single-duct air terminal units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017820 "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Air Terminal Units – Furnish one spare unit, of each size terminal unit.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

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.

2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Johnson Controls.
2. Krueger.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Price Industries.
6. Titus.
7. Trane; a business of American Standard Companies.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud. Only fully encased units will be accepted.

C. Casing: 0.034-inch steel, single wall.

1. Casing Lining: Adhesive attached, 1/2-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, 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 E 84.

a. Cover liner with nonporous foil.
b. Cover liner with nonporous foil and perforated metal.

2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to

140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

G. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."

3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

H. Control Sequence (See Drawings):

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. System-powered, wall-mounted thermostat.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Steel Cables: Galvanized steel complying with ASTM A 603.

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Louver face diffusers.
2. Drum louvers.
3. Fixed face grilles.
4. Louvers

B. Related Sections:
1. Section 233300 "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Louver Face Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Nailor Industries Inc.
    b. Price Industries.
    c. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Anodized aluminum.
5. Face Size: 24 x 24.
6. Mounting: T-bar.
7. Pattern: Four-way core style.
8. Dampers: Radial opposed blade.
9. Accessories:

    a. Square to round neck adaptor.
    b. Adjustable pattern vanes.
    c. Equalizing grid.
    d. Wire guard.
    e. Sectorizing baffles.
    f. Operating rod extension.

2.2 HIGH-CAPACITY DIFFUSERS

A. Drum Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Krueger.
    b. Nailor Industries Inc.
    c. Price Industries.
    d. Titus.

2. Airflow Principle: Extended distance for high airflow rates.
3. Material: Aluminum, heavy gage extruded.
4. Finish: White baked acrylic.
5. Border: 1-1/4-inch width with countersunk screw holes.
6. Gasket between drum and border.
7. Body: Drum shaped; adjustable vertically.
8. Blades: Individually adjustable horizontally.
9. Mounting: Surface to duct.

10. Accessories:

    a. Opposed-blade steel damper.
    b. Duct-mounting collars with countersunk screw holes.

2.3 REGISTERS AND GRILLES

A. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Krueger.
    b. Nailor Industries Inc.
    c. Price Industries.
    d. Titus.

2. Material: Aluminum.
3. Finish: Anodized Aluminum.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid Perforated core.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting: Lay in.

B. Louvers

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. Ruskin
    b. Anemostat Products; a Mestek company.
    c. Nailor Industries Inc.
    d. Titus.

2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Arrangement: louvered blades- drainable with extended sills.
5. Distribution plenum where required.

    a. Internal insulation.
    b. Damper, motorized.

6. Frame: 1-1/4 inches wide.
7.
8. Mounting: Countersunk screw.
9. Damper Type: Adjustable opposed blade.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where COTR features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 234100 - PARTICULATE AIR FILTRATION

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. Pleated panel filters.
2. Filter gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.
b. Camfil Farr.
c. Filtration Group.
d. Flanders-Precisionaire.
e. Purafil, Inc.

B. Filter Unit Class: UL 900, Class 1.

C. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.

1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Media shall be coated with an antimicrobial agent.
4. Separators shall be bonded to the media to maintain pleat configuration.
5. Welded wire grid shall be on downstream side to maintain pleat.
6. Media shall be bonded to frame to prevent air bypass.
7. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Capacities and Characteristics (See Drawings):

2.2 FILTER GAGES

A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Dwyer Instruments, Inc.

2. Diameter: 4-1/2 inches.

3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg or Less: 0- to 0.5-inch wg.
4. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg or Less: 0- to 1.0-inch wg.
5. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg or Less: 0- to 2.0-inch wg.

B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gage for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling-unit installations.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Operate automatic roll filters to demonstrate compliance with requirements.
2. Test for leakage of unfiltered air while system is operating.

D. Air filter will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 237314 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

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. Constant-air-volume, single-zone air-handling units.
2. Variable-air-volume, multiple-zone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

1.4 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions, configuration, and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories, including bearings.
    d. Motor ratings, electrical characteristics, and motor accessories.
    e. Material gauges and finishes

4. Certified coil-performance ratings with system operating conditions indicated.
5. Filters with performance characteristics.

B. Source and field quality-control test reports.

C. Operation and Maintenance Data: For air-handling units to include operation, and maintenance manuals, as per Section 01 78 20.

D. Response to the specifications:

1. The manufacturer shall submit a point by point statement of compliance with the specifications.
2. The statement of compliance shall consist of a list of numbered paragraphs. Each specification paragraph shall be cross referenced to the page/drawing in the submittal on which the compliance is confirmed; the confirming data on the page/drawing shall be highlighted for ready identification.
3. Where the proposed system complies fully, indicate by placing the word "comply" opposite the paragraph number.
4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, provide a full description of the deviation.
5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. A submittal, which does not include a point by point statement of compliance, as specified, shall be rejected.

E. Resubmittals shall:

1. Respond to each of the Government’s previous submittal review comments.
2. Clearly identify each change that differs from the previous submittal. Cloud changes made to drawings. Changes that are made and not identified will not be considered.

1.5 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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

G. Comply with applicable 2009 International Codes published by ICC (International Code Congress)

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Air handling unit shall be central-station type, factory fabricated and tested, and sectionally or fully assembled, certified in accordance with ARI 410 and ARI 430, and shall bear the ARI label. The air handling unit shall include components and auxiliaries in accordance with ARI 410. The manufacturer basis of design shall be as shown on the drawings and an approved equal product that meets all requirements of the specifications may be provided in lieu of the product shown. Fan selections shall be made for highest possible fan static efficiency while maintaining fan operation to the right of the surge point during the full range of capacity modulation. Above 3 inches water gauge total static pressure, airfoil or backward inclined fan blades should be used in lieu of forward curved blades. The fan selection shall include all system effect factors, in accordance with AMCA Publication 201.

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced, double-wall, insulated panels, fabricated to allow removal for access to internal parts and components.

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Materials and Finish: Casing may be constructed with mill-galvanized sheet metal conforming to ASTM A653 coated with not less than 1.25 ounces of zinc per square foot of two-sided surface or carbon steel with prime and paint or powder baked enamel. Mill rolled structural steel shall be hot-dip galvanized, primed, and painted, or powder baked enamel. All carbon steel shall be painted for corrosion protection.
5. Outside casing shall be constructed of a minimum 20 gage thickness of either galvanized or coated carbon steel.
6. Inside casing shall be constructed of a minimum 20 gage solid surface aluminum. The fan section shall be perforated.
7. Flooring shall be constructed of 12 gage aluminum.
8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type II (board insulation).

2. Location and Application: Encased between outside and inside casing. Insulation shall be 2-inch thick, 1.5 pcf density.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
b. Gasket: Neoprene, applied around entire perimeters of panel frames.
c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:

a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
b. Gasket: Neoprene, applied around entire perimeters of panel frames.
c. Size: At least 24 inches wide by full height of unit casing up to a maximum height of 72 inches.

4. Locations and Applications:

a. Fan Section: Doors sized for fan and motor removal and replacement.
b. Access Section: Doors.
c. Coil Section: Inspection and access panel.
d. Filter Section: Doors large enough to allow periodic removal and installation of filters.
e. Mixing Section: Doors.

5. Service Light: 100-W vaporproof fixture with switched junction box located outside adjacent to door.

a. Locations: Fan section.

D. Condensate Drain Pans:

1. Fabricated with **two** percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2007.
b. Depth: A minimum of 3 inches deep.

2. Formed sections.
3. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

a. Minimum Connection Size: NPS 1-1/4.

5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

6. Provide auxiliary drain pans with independent drain piping where units are mounted above occupied spaces or operating equipment. Auxiliary drain pans and piping shall be constructed to meet requirements specified above.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced after mounting on shafts and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
4. Internal Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

1) Fabric Minimum Weight: 26 oz./sq. yd.
2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

D. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

F. Fan Shaft Bearings:

1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated L50 life of 250,000 hours according to ABMA 9.
2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated L50 life of 250,000 hours according to ABMA 11.
3. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.

G. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Pulleys: Cog-type cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Pulleys shall be fixed pitch cog type. Contractor shall provide the final set of sheaves required to meet final system Test and Balance requirements.
3. Belts: Cog V type, oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives. Belts shall be rated for 150% of nameplate motor horsepower.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

H. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches.

I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23, Section 23 05 13, "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: As indicated.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Mount unit-mounted disconnect switches on exterior of unit.

J. Variable Frequency Controllers: Comply with requirements for variable frequency controllers specified in Division 26, Section 26 29 23, “Variable Frequency Controllers.”

2.4 COIL SECTION

A. Cooling and heating coils shall comply with Division 23, Section 23 82 14, Air Coils.

B. General Requirements for Coil Section:

1. Comply with ARI 410.

2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s). Coils shall have a minimum of 24 inches separation between coil sections and a minimum of 24 inches separation between coil sections and other system components, such as filters.
3. Coil section shall encase cooling coils and drain pans. Completely enclose coil headers with the insulated casing with only connections extended through the cabinet.
4. Provide intermediate drain pans for multiple coils.
5. Coils shall not act as structural component of unit.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
4. Air handling units shall be equipped with a pre-filter of Extended Surface, Disposable Panel type, and with a final filter of Extended Surface, Non-Supported type, or as otherwise shown. Filter efficiencies and other characteristics shall be as specified in this paragraph, or as otherwise shown.

B. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.
2. Thickness: 2 inches.
3. Recommended Final Resistance: 0.8.
4. Arrestance (ASHRAE 52.1): 90.
5. Merv (ASHRAE 52.2): 13.
6. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
7. Media-Grid Frame: Nonflammable cardboard.
8. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.6 DAMPERS

A. General Requirements for Dampers: Dampers shall be as specified in Division 23, Section 230900, HVAC Instrumentation and Controls.

B. Damper Actuators: Comply with requirements in Division 23, Section 230900, HVAC Instrumentation and Controls Cx.

2.7 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases without vibration isolation devices, unless otherwise noted. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23, Section 23 05 48.13, "Vibration Controls for HVAC Piping and Equipment."

B. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Division 23, Section 23 05 48.13, "Vibration Controls for HVAC Piping and Equipment."

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

E. Install static-pressure taps upstream and downstream of filters. Plastic plugs shall not be used.

F. Fan Sheaves: Fan sheaves shall be fixed type and appropriate sized sheave shall be furnished with the air handling unit. Adjustable sheaves are not acceptable. Test and balance contractor

shall specify fixed sheave size, where change in size is required to meet to design air flow requirements, and contractor shall furnish and install final sheaves.

3.3 ALIGNMENT

A. The Contractor shall provide laser alignment of fan motor sheaves, fan sheaves, and fan belt before operation of the air handling unit, and at the completion of the test and balance of the air handling system. Other methods of fan belt alignment will not be accepted. The Government reserves the right to verify fan belt alignment and require re-alignment where necessary. Belt driven equipment shall be precision aligned with a laser tool such as Vibralign Belt Hog Laser Alignment tool with a minimum sheave skew of .002 inch per the NASA RCM Guide Appendix G Section 4.0.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain, or as otherwise shown. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valves, unions, balancing valves, and flanges at each coil supply and return connection as shown.

F. Connect duct to air-handling units with rigid connections, where internal vibration isolation is provided. Comply with requirements in Division 23 Section "Air Duct Accessories."

3.5 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. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Coordinate startup with NASA Commissioning Agent. NASA Base Maintenance representatives shall be present for system startup.

B. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that face-and-bypass dampers provide full face flow.
7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
8. Comb coil fins for parallel orientation. Inspect coils for cleanliness and remove any foreign materials or deposits.
9. Verify that proper thermal-overload protection is installed for electric coils.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.8 CLEANING

A. After completing system installation, and before unit startup, thoroughly clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings.

B. After air handling unit startup, and before testing, balancing, and adjusting, verify the cleanliness of the air handling system and clean, as necessary, to remove any debris that may have been dislodged during initial system operation. Install new, clean filters.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237314

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

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. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year from date of Substantial Completion.
c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. SANYO North America Corporation; SANYO Fisher Company.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: High impact plastic with removable panels on front and ends and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

3. Fan: Direct drive, centrifugal.
4. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Enclosure Type: Totally enclosed, fan cooled.
    d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
    e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
    f. Mount unit-mounted disconnect switches on exterior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 1 inch deep.

    b. Single-wall, stainless-steel sheet.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

        1) Minimum Connection Size: NPS 1.

    d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

7. Air Filtration Section:

    a. General Requirements for Air Filtration Section:

        1) Comply with NFPA 90A.
        2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
        3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

    b. Washable Panel Filters:

        1) Factory-fabricated, viscous-coated, flat-panel type.
        2) Merv according to ASHRAE 52.2: 5.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, 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. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-410A.
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC".

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Drain Hose: For condensate.

2.5 CAPACITIES AND CHARACTERISTICS

A. Cooling Capacity (See Drawings):

B. Heating Capacity (See Drawings):

C. Indoor Unit (See Drawings):

D. Outdoor Unit (See Drawings):

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548.13 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238214 – AIR COILS

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. This Section includes the following types of air coils that are not an integral part of air-handling units:

1. Hot-water.
2. Chilled-water.
3. Refrigerant.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals, as per Section 017820.

E. Response to the specifications:

1. The manufacturer shall submit a point by point statement of compliance with the specifications.
2. The statement of compliance shall consist of a list of numbered paragraphs. Each specification paragraph shall be cross referenced to the page/drawing in the submittal on which the compliance is confirmed; the confirming data on the page/drawing shall be highlighted for ready identification.
3. Where the proposed product complies fully, indicate by placing the word "comply" opposite the paragraph number.
4. Where the proposed product does not comply, or accomplishes the stated function in a manner different from that described, provide a full description of the deviation.
5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. A submittal, which does not include a point by point statement of compliance, as specified, shall be rejected.

F. Resubmittals shall:

1. Respond to each of the Architect/Engineer's previous submittal review comments.

G. Clearly identify each change that differs from the previous submittal. Cloud changes made to drawings. Changes that are made and not identified will not be considered

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with applicable 2009 International Codes published by ICC (International Code Congress

C. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

1.5 PROJECT CONDITIONS

A. Altitude above Mean Sea Level: 500 feet, unless otherwise specified.

PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: The manufacturer basis of design shall be as shown on the drawings and an approved equal product that meets all requirements of the specifications may be provided in lieu of the product shown.

B. Coil Design and Performance.
1. The specified coil Btu capacities, face area, and number of rows are the minimum acceptable. Air pressure drop, water pressure drop, fin spacing, and face velocity are the maximum acceptable.
2. Coils shall be counterflow design, air-to-water.
3. Design coils to be self venting. Provide the coil water supply header with its connection at the lowest point on the header. Coil water return header shall have its connection at the highest point on the header. Furnish the coil supply header and return header with a vent connection as specified at the highest point of each header.
4. Coils shall have supply and return piping connections on the same end of the coil.
5. Coil design shall be staggered tube plate fin.

6. Coils shall have all circuits drainable when coils are installed with tubes horizontal and level. Coil return header and supply header shall be furnished with a drain connection as specified at the lowest point on the header.
7. Hot water coils shall be suitable for system operating temperatures up to 325 degrees F at system operating pressures up to 200 psig. Coil ratings shall meet or exceed system operating parameters.

C. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

D. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

E. Source Quality Control: Factory tested to 300 psig underwater.

F. Tubes: ASTM B 743 copper, minimum 0.025 inch thick for 0.5 inch tube diameter and 0.035 inch thick for 5/8 inch tube diameter.

G. Fins: ASTM B209 alloy 1100 aluminum, minimum 0.010 inch. Fins shall have collars for accurate spacing and maximum tube contract.

H. Headers: ASTM B88, seamless copper tube with brazed joints, prime coated

I. Frames: Galvanized-steel channel frame, minimum 0.0625 inch thick for [**slip-in**] [**flanged**] mounting.

J. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in or flanged mounting.

K. Hot-Water Coil:

1. Coil Configuration: Horizontal tubes.

L. Hot-Water Coil Capacities and Characteristics:

1. Coil Face Dimensions:

2. Minimum Fin Spacing: 12.e.
3. Tube Diameter: 0.50 inch.
4. Number of Rows: 2.
5. Coating: Baked phenolic.
6. Air Side:

    a. Flow Rate: See drawing schedule**.**
    b. Finned Area Face Velocity: See drawing schedule**.**
    c. Static Pressure Drop: See drawing schedule**.**
    d. Total Capacity: See drawing schedule**.**
    e. Entering Temperature: See drawing schedule**.**
    f. Leaving Temperature: See drawing schedule**.**

7. Water Side:

    a. Flow Rate: See drawing schedule**.**
    b. Pressure Drop: See drawing schedule**.**

c. Entering Temperature: See drawing schedule.
d. Leaving Temperature: See drawing schedule.

M. Chilled-Water Coil Capacities and Characteristics:

1. Minimum Fin Spacing: 12.
2. Tube Diameter: 0.50 inch.
3. Number of Rows: 2.
4. Coating: Baked phenolic.
5. Air Side:

a. Flow Rate: See drawing schedule.
b. Finned Area Face Velocity: See drawing schedule.
c. Static Pressure Drop: See drawing schedule.
d. Total Capacity: See drawing schedule.
e. Sensible Capacity: See drawing schedule.
f. Entering Dry-Bulb Temperature: See drawing schedule.
g. Entering Wet-Bulb Temperature: See drawing schedule.
h. Leaving Dry-Bulb Temperature: See drawing schedule.
i. Leaving Wet-Bulb Temperature: See drawing schedule.

6. Water Side:

a. Flow Rate: See drawing schedule.
b. Pressure Drop: See drawing schedule.
c. Entering Temperature: See drawing schedule.
d. Leaving Temperature: See drawing schedule.

2.2 REFRIGERANT COILS

A. Manufacturers: The manufacturer basis of design shall be as shown on the drawings and an approved equal product that meets all requirements of the specifications may be provided in lieu of the product shown.

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.006 inch thick.

G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

I. Capacities and Characteristics:

1. Minimum Fin Spacing: 0.125 inch.
2. Tube Diameter: 0.50 inch.
3. Coating: Baked phenolic.
4. Air Side:

    a. Static Pressure Drop: See drawing schedule**.**
    b. Total Capacity: See drawing schedule**.**
    c. Sensible Capacity: See drawing schedule**.**
    d. Entering Dry-Bulb Temperature: See drawing schedule**.**
    e. Entering Wet-Bulb Temperature: See drawing schedule**.**
    f. Leaving Dry-Bulb Temperature: See drawing schedule**.**
    g. Leaving Wet-Bulb Temperature: See drawing schedule**.**

5. Refrigerant Side:

    a. Refrigerant Type: R-134a or equivalent HCFC-based refrigerant

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless-steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1-2007.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23, Section 23 09 00, HVAC Instrumentation and Controls Cx and other piping specialties are specified in Division 23, Section 23 21 13, "Hydronic Piping."

D. Connect refrigerant piping according to manufacturer’s installation manual, and per specific equipment requirements.

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 238214

SECTION 238239.16 - PROPELLER UNIT HEATERS

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 propeller unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.3

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which propeller unit heaters will be attached.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airtherm; a Mestek company.
2. Engineered Air.
3. Rosemex Products.
4. Ruffneck Heaters; a division of Lexa Corporation.
5. Trane Inc.

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in vertical discharge configuration with adjustable discharge louvers.

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 UL 2021.

D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

A. Control Devices:

1. Unit-mounted thermostat.

2.8 CAPACITIES AND CHARACTERISTICS

A. Heating Capacity (See Drawings):

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548.13 "Vibration Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties". " Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

SECTION 260501 - ELECTRICAL TESTING

PART 1 GENERAL

1.1 This section covers the general and administrative requirements for testing of electrical systems, materials, and equipment.

A. The Contractor shall engage the services of a recognized independent testing firm for the purpose of performing inspections and tests as herein specified and in other Division 26 Sections. The Contractor shall submit the name and qualifications of the testing firm to the COTR for approval within 30 days after Notice to Proceed.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. It is the purpose of these specifications to ensure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

D. The tests and inspections shall determine suitability for energization.

E. Refer to individual Division 26 sections for equipment and systems to be tested and detailed test requirements.

1.2 QUALITY ASSURANCE

A. Testing Firm

1. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
2. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
3. The testing firm shall utilize technicians who are regularly employed by the firm for testing services.
4. The testing firm shall submit proof of the above qualifications for approval from the Engineer.

B. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Field test metering used to check power system meter calibration must have an accuracy higher than that of the instrument being checked.
3. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of 2 percent of the scale used.
4. Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

C. Test Instrument Calibration

1. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).

2. Instruments shall be calibrated in accordance with the following frequency schedule:

   a. Field Instruments: Analog, 6 months maximum; Digital, 12 months maximum
   b. Laboratory Instruments: 12 months
   c. Leased Specialty Equipment: 12 months where accuracy is guaranteed.

3. Dated calibration labels shall be visible on all test equipment.
4. Records, which show date and results of instruments calibrated or tested, must be included in the test report.
5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.3 DIVISION OF RESPONSIBILITY

A. The Contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

B. The Contractor shall supply electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The Contractor shall provide and submit for approval a short-circuit analysis and coordination study prior to completion of testing. The Contractor shall provide a complete set of electrical plans, specifications and change orders, as well as pertinent shop drawings, and manufacturer's instructions to the testing firm prior to commencement of testing. Coordination study shall include required set-points for coordinated devices.

E. The testing firm shall notify the COTR two weeks prior to commencement of any testing.

F. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported. The COTR will direct the Contractor to repair or replace the defective materials or equipment depending upon the effect.

G. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report.

1.4 SUBMITTALS

A. Submittals for project closeout.

1. Test Reports: The test reports shall include the following:

a. Summary of project
b. Description of equipment tested
c. Description of test and identification
d. Test results
e. Analysis and recommendations and remedial actions taken.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 The Contractor shall perform all tests required by individual Division 26 sections.

3.2 MOTOR TESTS: The independent testing firm shall perform and document the following inspections and tests on motors:

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with approved Shop Drawings.
2. Inspect physical and mechanical condition.
3. Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 10.12.
5. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

B. Electrical Tests - Induction Motors

1. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
   a. Motors 200 Horsepower and Less: Test duration shall be for 1 minute. Calculate the dielectric-absorption ratio.
   b. Perform insulation-resistance test on pedestal in accordance with manufacturer's published data.
   c. Verify that resistance temperature detector (RTD) circuits conform to Drawings.
   d. Verify that metering or relaying devices using the RTD's have the correct rating.
   e. Verify that the motor space heater is functional where applicable.
   f. Perform a rotation test to ensure correct shaft direction.
   g. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

3.3 THERMOGRAPHIC SURVEY: The independent testing firm shall perform and document the baseline thermal operating conditions of all panels and electrical connections as described herein.

A. Visual and Mechanical Inspection

1. Inspect physical, electrical and mechanical condition.
2. Remove all necessary covers prior to thermographic inspection.

B. Provide report including the following:

1. Baseline conditions.
2. Discrepancies.
3. Temperature difference between the area of concern and the reference area.
4. Cause of temperature difference.
5. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
6. Identify load conditions at time of inspection.
7. Provide photographs and/or thermograms of the baseline conditions and of all deficiencies.

C. Test Parameters

1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 degree C at 30 degrees C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to NFPA 70B-1998, Section 18-17 (Infrared Inspection).

D. Test Results

1. Temperatures differences of 1 degree C to 3 degrees C indicate possible deficiency and shall be referred to the COR for direction to repair.
2. Temperature differences over 4 degrees C shall be repaired by the Contractor and retested by the testing firm.

END OF SECTION 260501

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.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-THWN-2 Conductors shall be #12 CU minimum.

2.2 CONNECTORS AND SPLICES

A. 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-THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN-2, single conductors in raceway.

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.

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: Engage a qualified testing agency to 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:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. 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.

E. 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.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017820 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at 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. Recommended testing intervals of once every three years.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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.

2.2 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. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 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 or copper alloy.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

3.2 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.

3.3 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. 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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. 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. 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 fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. 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: 3 ohm(s).

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify NASA 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. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
4. Toggle Bolts: All-steel springhead type.
5. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

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 except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacing less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Existing Concrete: Expansion anchor fasteners.
2. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts spring-tension clamps.
3. To Light Steel: Sheet metal screws.
4. 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 meet seismic-restraint strength and anchorage requirements.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. 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.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

C. PVC: Polyvinyl Chloride

D. EMT: Electrical Metallic Tubing

E. FMC: Flexible Metallic Conduit

F. LFMC: Liquid Tight Flexible Metallic 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.

PART 2 - PRODUCTS

2.2 METAL CONDUITS, TUBING, AND FITTINGS

A. 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.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. IMC: Comply with ANSI C80.6 and UL 1242.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. 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 (1 mm), with overlapping sleeves protecting threaded joints.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 12 unless otherwise indicated, and sized according to NFPA 70.

B. 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.

C. Wireway Covers: Flanged-and-gasketed type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.

D. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).

I. Gangable boxes are allowed.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, Type 12 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.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.

3. Exposed and Subject to Severe Physical Damage: GRC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1.

B. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

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 NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) 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. Support within 12 inches (300 mm) 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 (300 mm) of enclosures to which attached.

I. 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.

J. 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.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

L. 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 (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. 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.

O. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Q. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

R. 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.

S. 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 otherwise required by NFPA 70.

T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) 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.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for 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.

W. 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 bottom of box unless otherwise indicated.

X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Y. Locate boxes so that cover or plate will not span different building finishes.

Z. 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.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 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."

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

SECTION 260538 - PULL AND JUNCTION BOXES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Provide pull and junction boxes of appropriate size and depth or as indicated on the drawings and as specified hereinafter.

1.2 SUBMITTALS

A. Submittals of products furnished under this section are not required.

PART 2 PRODUCTS

2.1 MATERIALS

A. For interior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4 inch flanges, screw covers, etc.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide junction boxes as shown on drawings and otherwise where required, sized according to number of conductors in box or type of service to be provided. Minimum junction box size 4 inches square and 2-1/8 inches deep. Provide screw covers for junction boxes.

B. Use minimum 16 gauge steel for pull boxes and provide with screw cover.

C. Install boxes in conduit runs wherever necessary to avoid long runs or excessive bends. Do not exceed 100 foot runs, or three 90 degree bends, without pull boxes.

D. Rigidly secure boxes to walls, structure or ceilings. Use of conduit as a support is not acceptable.

E. Install boxes in accessible locations. Size boxes in accordance with Articles No. 312 and No. 314 of the latest edition of the National Electrical Code.

F. Install boxes so that the covers will be accessible at all times.

G. Do not install pull or junction boxes for joint use of line voltage and signal or low voltage controls unless all conductors are insulated for the highest voltage being used in the same

box. Emergency system and normal system circuits shall not be routed through a common pull or junction box.

H. Contractor to spot paint all boxes inside and out per the following color code:
   1. Green: Emergency Power/Equipment Branch
   2. Red: Fire Alarm System

I. Contractor to label each junction box with the associated branch circuit installed.

END OF SECTION 260538

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 Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

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. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel 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.

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 (34.5-MPa), 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.
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. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. 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.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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.

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. This Section includes the following:

1. Identification for raceways.
2. Identification for power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Miscellaneous identification products.
6. Wiring device identification labels.

1.3 QUALITY ASSURANCE

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ASME A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600V and less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Colors for Raceways Carrying Circuits at More Than 600V:

1. Black letters on an orange field.
2. Legend: “DANGER CONCEALED HIGH VOLTAGE WIRING.”

D. Vinyl Labels for Raceways Carrying Circuits at 600V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted or write-on, 3-mil-thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.7 WIRING DEVICE IDENTIFICATION LABELS

A. 1/2-inch clear permanent polyester tape for industrial purposes.

B. 1/4-inch black letters on clear tape with circuit numbers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels with mechanical fasteners appropriate to the location and substrate.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line 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.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, Armored and Metal-Clad Cables More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

D. 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 conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral: White with color strip to indicate associated phase or white with color tape to indicate associated phase.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
4) Neutral: Gray with color strip to indicate associated phase or gray with color tape to indicate associated phase.

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.

E. 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.

F. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive vinyl labels with the conductor designation.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: 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.

K. 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 systems unless equipment is provided with its own identification.

1. Labeling Instructions:

   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where 2 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. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Circuits to be traced down by the electrical contractor. No circuit shall be named “Existing Circuit”. Panelboard identification shall be engraved laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Switchgear.
   d. Switchboards.
   e. Motor-control centers.
   f. Enclosed switches.
   g. Enclosed circuit breakers.
   h. Variable-speed controllers.
   i. Wiring device cover plates.

L. Wiring Devices: Make and install a polyester tape label with branch circuit number on each wiring device.

M. Junction Boxes:

   1. Exposed – Provide a tape label with circuit number(s).
   2. Concealed – Permanent black marker on blank cover with circuit number(s).

END OF SECTION 260553

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.
3. Load centers.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. 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. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.
7. 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.

1.5 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 017820 "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 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. 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.

D. 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.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.8 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 NECA 407.

1.9 PROJECT 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:

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 Owner no fewer than 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.

1.10 COORDINATION

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.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

   ~~a.~~ Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   c. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: galvanized 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.

7. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.5 LOAD CENTERS

A. Load Centers: Comply with UL 67.

B. Mains: Circuit breaker.

C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

D. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. 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.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    f. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    g. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
    i. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
    j. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    k. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    l. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

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 distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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 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.

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. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:
   1. Solid-state fan speed controls.
   2. Wall-switch and exterior occupancy sensors.

1.4 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. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 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. 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.

2.4 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A.

2.5 WALL BOX DIMMERS

A. Dimmer Switches: Modular, full wave, solid state units with integral, quiet of off switches with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider with single pole switching. Comply with UL 1472.

C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballast; trim potentiometer to adjust low end dimming; dimmer ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.6 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: 0.04-inch- (1-mm-) thick steel with chrome-plated finish.
3. Material for Unfinished Spaces: Galvanized steel.

2.7 FINISHES

A. Device Color: As selected by NASA

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. Pigtailing 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 (152 mm) 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. 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.

F. 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.

3.2 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 or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Wiring device will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Plug fuses rated 125-V ac and less for use in plug-fuse-type fuseholders.
2. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Sections 017820 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

3. Coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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 FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.2 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.3 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Feeders: Class L, time delay.
2. Motor Branch Circuits: Class RK1, time delay.
3. Other Branch Circuits: Class RK1, time delay.
4. Control Circuits: Class CC, fast acting.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, dual Type S, dual element time delay.
2. Other Branch Circuits: Edison-base type, single-element fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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. Receptacle switches.
4. Molded-case circuit breakers (MCCBs).
5. Molded-case switches.
6. 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 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 017820 "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 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. 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.

E. Comply with NFPA 70.

1.8 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 (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

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 no fewer than 14 days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without written permission.
4. Comply with NFPA 70E.

1.9 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. Type HD, Heavy Duty, Single Throw, 240 or 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.

B. Type HD, Heavy Duty, Double Throw, 240 or 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 240 or 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.

B. Type HD, Heavy Duty, Double Throw, 240 or 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
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. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time time adjustments.
3. Ground-fault pickup level, time delay, and I^2t response.

E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

F. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression 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.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.4 MOLDED-CASE SWITCHES

A. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

B. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.5 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 12.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

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. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. 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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. 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.

D. 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.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. 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.

B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262816

SECTION 262923 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFD: Variable frequency drive.

1.3 SUBMITTALS

A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Each installed unit's type and details.
   b. Nameplate legends.
   c. Short-circuit current rating of integrated unit.
   d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

C. Qualification Data: For manufacturer**.**

D. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Acceptable storage temperatures shall be between -25 degrees C and 65 degrees C.

C. If stored in areas subject to weather, cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: -10 to 50 deg C.

2. Humidity: Less than 95 percent (noncondensing).

B. 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 Owner no fewer than 14 days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical service without Owner's written permission.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. If required, coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of 380 to 500 V, plus 10 or minus 15 percent.
2. Nameplate rated for full ampacity at 50 degree C ambient over the entire range of carrier frequency.
3. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
4. Minimum Efficiency: 98 percent at 60 Hz (100% speed) and full rated load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent.
6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
7. Starting Torque: 100 percent of rated torque or as indicated.
8. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors from phase to phase and from phases to ground.
2. Incoming line reactor (s) to prevent harmonic distortions.
3. All drive boards conformal coated to protect from electrical shorts in dirty environments.
4. Internal power connections shall be solid copper bus construction.
5. IGBT technology shall reduce the voltage spike commonly inherent with IGBT's by modifying the DV/DT turn-on profile.
6. Combination enclosure contains ball-bearing fans for cabinet and heat-sink cooling that are accessible from the front without removal of the ac power drive converter. The cabinet fan shall utilize a thermal sensor control on the IGBT board to control fan start and stop.
7. Under- and overvoltage trips; inverter over-temperature, overload, and overcurrent trips.
8. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
9. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
10. Instantaneous line-to-line and line-to-ground overcurrent trips.
11. Loss-of-phase protection.
12. Reverse-phase protection.
13. Short-circuit protection.
14. Motor over-temperature fault.

H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

M. Input Line Conditioning: Incoming line reactor (s) to prevent harmonic distortions.

N. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Drive power on (Red).
2. Drive run (Green).
3. Drive fault (Yellow).

O. Panel-Mounted Operator Station should be equipped with a DRIVE-OFF-BYPASS selector switch and a HAND-OFF-AUTO selector switch. Bypass mode will allow the operator to start and stop the motor across the line and independent of the VFD. Hand mode enables the drive to operate at a selected speed set up through the keypad. Auto mode enables the drive to be started, stopped, and controlled through the BAS.

P. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

Q. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. An operator interface keypad and display for local programming and speed control. The keypad shall be both detachable and interchangeable with other VFDs of the same manufacturer and type.

3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Local keypad.

4. Output Signal Interface:

   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).

5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (over-temperature or overcurrent).
   d. PID high- or low-speed limits reached.

R. Communications: Drive shall have serial communication options using BACNet MSTP, METASYS N2, or MODBUS. The preferred choice is BACNet MSTP. The BAS shall be able to monitor the drive status, such as speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, dc voltage, motor thermal state, elapsed time and motor speed including the mode of operation of the drive through the serial communication system. All control functions shall be controllable through the BAS system. Provide capability for VFD to retain these settings within the nonvolatile memory.

S. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. DRIVE-OFF-BYPASS selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

T. Bypass Controller: NEMA ICS 2, full-voltage, non-reversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under

both modes of operation with control logic that allows common start-stop capability in either mode.

U. Integral Disconnecting Means: NEMA KS 1, non-fusible switch lockable handle.

V. Isolating Switch: Non-load-break switch arranged to isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

W. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.2 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Control Relays: Auxiliary and adjustable time-delay relays.

D. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

E. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

F. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFDs in accordance with manufacturer’s instruction manual, applicable requirements of NEC, and in accordance with recognized industry practices.

C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 26 Section "Electrical Identification."

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to Division 26 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 "Grounding and Bonding."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 ON-SITE DEMONSTRATION, TESTING, AND TRAINING

A. The manufacturer shall provide on-site training for all customers required personnel in the operation and maintenance of the system. The manufacturer shall provide the VFD software for the customer’s ability to modify the program parameters. The manufacturer shall provide 24/7

technical assistance utilizing a toll free number for accessibility. Refer to Division 1 Section "Demonstration and Training."

B. System testing should include, but not be limited to, the following:

1. Provide a complete functional startup and test of the VFD at the customer's site.
2. Provide the services of a field service engineer for the site testing and installation supervision as required.
3. Provide a written report certifying the equipment is installed and tested to the full satisfaction of the manufacturer.

END OF SECTION 262923

SECTION 265100 - INTERIOR 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. Interior lighting fixtures, lamps, and ballasts.
2. Lighting fixture supports.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LED: Light Emitting Diode

F. LER: Luminaire efficacy rating.

G. Lumen: Measured output of lamp and luminaire, or both.

H. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Installation instructions.

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. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures 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 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program 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, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

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.

1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 WARRANTY

A. 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 Lighting Unit Batteries: Ten (10) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine (9) years.
2. Warranty Period for Emergency Fluorescent Ballast Batteries: Seven (7) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six (6) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on drawings as basis of design.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

D. 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.

E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
b. UV stabilized.

F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. 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 and ballast characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
d. CCT and CRI for all luminaires.

G. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LED TROFFERS

A. General
1. LED light fixtures shall be in accordance with IES, NFPA, UL as shown on the drawings and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) – Compliant.
3. LED drivers shall include the following features unless otherwise indicated:
a. Minimum Efficiency: 85% at full load.
b. Minimum Operating Ambient Temperature: -20 degrees C (-4 degrees F)
c. Input Voltage: 277 V (±10%) at 60 Hz.
d. Integral short circuit, open circuit and overload protection.
e. Power Factor: ≥ 0.95
f. Total Harmonic Distortion: ≤ 20%

B. Optical Technology
   1. High efficiency white light provided by mixing the luminous flux from unsaturated yellow and red LEDs.
   2. Active color management to maintain color consistency over time and temperature.
   3. Every light engine tuned as a complete system before shipment to ensure color consistency from luminaire.
   4. High efficiency 90 CRI option providing 130 lumens per watt. Designed for 100,000 hour lifetime.
   5. Standard efficiency 90 CRI provides 100 lumens per watt. Designed for 75,000 hour lifetime.
   6. High definition 80 CRI option provides 90 lumens per watt. Designed for 50,000 hour lifetime.
   7. Luminaires to be provided in 3500 k color temperature.

C. Thermal Management
   1. Room side heat sink to maximize cooling effectiveness by conducting heat away from the LEDs and into the temperature controlled environment.

D. Construction
   1. 20 gage steel housing with standard troffer access plate for electrical installation.
   2. Reflector finished with a textured high reflectance white polyester powder coating.
   3. Field replaceable light engine integrates LEDs, driver, power supply, thermal management and obtical mixing components.
   4. Individual luminaires may be continuous row mounted end-to-end.

E. Optical System
   1. Combination of reflective and refractive components to achieve uniform appearance.
   2. No pixilation, color fringing or direct view of unshielded LEDs.

F. Electrical System
   1. Integral, high efficiency driver and power supply.
   2. Normal power factor of 0.9.
   3. Step Dimming to 50% lighting level.
   4. 0-10 volt dimming available.

G. Emergency Driver
   1. Provide 1400 lumen battery backup integrated with driver.

H. LED drivers, modules and reflector shall be accessible, serviceable and replaceable from below the ceiling.

I. Housing, LED Driver and LED module shall be products of the same manufacturer.

J. Warranty
   1. Ten year limited warranty.

2.4 BALLASTS FOR LINEAR FLURESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A
5. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.95 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electronic Programmed-Start Ballasts for T8 Lamps: Comply with ANSI C82.11 and the following:
1. Automatic lamp starting after lamp replacement.

D. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

2.5 BALLAST FOR COMPATC FLOURESCENT LAMPS

A. Ballast for Dimmer Controlled Lighting Fixtures: Electronic Type
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

2.6 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate one (1) fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.

3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.7 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, and sutible for use with dimming ballast unless otherwise indicated.
    1. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

    1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
    2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. 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.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner.

END OF SECTION 265100