Repair Maintenance Shop
1081 2nd St
Building 8040

FNWZ 12-0053
Contract Number FA 4661-16-C-0003

Department of the Air Force
7th Contracting Squadron
Dyess Air Force Base, Texas

PROJECT MANUAL

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TABLE OF CONTENTS

PART 1 – GENERAL

1. SCOPE: The work covered by this project consists of the Contractor furnishing all layout, survey, plant, labor, supervision, quality control, materials, equipment, machines, tools, appliances, services, supplies, and incidentals and of performing all operations in connection with the task order at Dyess AFB, Texas, complete and in strict accordance with the plans and specifications.

a. Project Description: Wall to wall renovation of the maintenance shop facility to include replacing/upgrading interior finishes and utilities, repairing damaged roof and adding an addition to the facility. Work also involves installing safety equipment and removing outdated built-in shop equipment. In effect, work is to completely rehabilitate the facility to more modern standards with safer conveniences. Facility shall meet current corrosion control facility standards (ventilation/filtration/workflow).

b. Justification: Building 8040 was constructed in 1963 and hasn't had any major upgrades since built. Much of the building finishes are in disrepair and building utilities are outdated and undersized. The roof is damaged and building is still housing outdated built-in equipment that need to be removed. Building lacks modern safety requirements which are required for shop area utilizing toxic chemicals. The outdated facility is not efficient in its current operating state.

c. MACC contractor shall prepare a bid schedule based off the supplied design documents (drawings, specifications, & attachments), site visit, and any contractor questions & government responses.

d. Refer to Attachment A for contractor required commissioning of the salvaged & relocated paint booth. Also refer to drawings & specifications.

e. Refer to Attachment B for contractor Bid Schedule.

f. Refer to Attachment C for contractor pricing breakdown & submittal time.

g. There are NO opportunities for phasing on this project. Contractor will have full access to facility & immediate area for the duration of the project.

2. WORKING CONDITIONS: ***Contractor shall carefully consider the following when contemplating any specific task identified by the government reflecting any special or unusual conditions which may affect the Contractor's work such as:***

- ***work area availability***
- ***scheduling***
- ***required notice requirements***
- ***traffic control***
- ***temporary heating/cooling***
- ***required certificates prior to award***
- ***required work plans***
- ***any other special conditions***

3. WORK SCHEDULE: Working hours for the Contractor will normally be between the hours of 7:30 a.m. and 4:30 p.m. excluding Saturdays, Sundays, and Federal holidays. If the Contractor desires to work during periods other than above, additional government inspection forces may be required. The Contractor must make their request to the Contracting Officer five (5) calendar days in advance of their

intention to work during other periods to allow assignment of additional inspection forces. If such force is reasonably available, the Contracting Officer may authorize the Contractor to perform work during periods other than normal duty hours/days.

4. SAFETY AND HEALTH:

4.1 All Contractor operations shall be conducted and performed in accordance with Department of Labor, OSHA requirements found in 29 CFR 1910 and 29 CFR 1926, project identified national standards, military manuals, instructions, pamphlets, and standards and handbooks.

4.2 All companies who conduct business within the state of Texas must, in accordance with Texas Workman Compensation laws (Texas House Bill 62), have an approved company safety policy and an Accident Prevention Plan. The plan, approved by the Texas Workman Compensation Commission (TWCC), shall be submitted For Information Only (FIO) in accordance with paragraph SUBMITTAL REQUIREMENTS. In addition to meeting the TWCC requirements; the plan must also include the requirements of COE Safety Manual, latest edition.

4.3 All holes/pits/trenches/manway openings, etc, that are to be left open shall be surrounded with a 48 inch high mesh fence with highly visible orange plastic coating. The fence shall be securely anchored with tension wires and posts as required to prevent sagging and located a minimum of 3 feet from the opening so as to prevent an individual, should they fall across the fencing, from falling into the opening. Holes shall also be covered, when not being worked in, with three quarter inch plywood or a metal grating that will prevent small children from entering the hole. If the hole/pit is too large to cover, then a ladder of sufficient length shall remain in the hole/pit for egress.

4.4 Radiation Permits and Authorizations: Contractors contemplating the use of devices containing radioactive materials (i.e., soil moisture/density probes) or non-ionizing radiation producing equipment (radio frequency radiation emitters or lasers) while performing work on this contract must obtain written authorization/permit from the Dyess AFB Radiation Safety Officer (RSO), 7 AMDS/SGPB. To obtain the required authorization permit, an application to bring a radioactive device on Dyess AFB must be forwarded to 7 AMDS/SGPB, 697 Louisiana Loop, Dyess AFB, TX 79607-1367 (this is mailing address, physical address is 880 Third St.) or (325)696-2325 / 3289, at least 45 days prior to the anticipated use. Without the proper authorization, Contractors will not be allowed to bring these devices on base. Also, Contractor shall provide Bioenvironmental Engineering (7 AMDS/SGPB) a copy of contractor's radioactive materials permit and training certificates, if radioactive material will be brought onto Dyess AFB.

4.5 Confined Space Entry: All operations involving entry into confined spaces shall meet the requirements of OSHA 29 CFR 1910.146, AFOSH Std 91-25, and specifically the following:

a. All entry supervisors, attendees, and confined space entrants shall have been properly trained in the safety hazards, proper use of Personal Protective Equipment (PPE), entry procedures, and self-rescue. Records of this training must be readily available.

b. Entry supervisors shall maintain a Master Entry Plan (MEP) consisting of:
   (1) Descriptions of confined spaces to be entered including location, classification, and acceptable entry conditions
   (2) Designation of authorized entry supervisors, entrants, and attendees
   (3) Identification of the types of tasks to be performed in the confined space, including duration
   (4) Procedures for entry, and emergency rescue
   (5) Identification of Personal Protective Equipment (PPE), communication equipment, rescue equipment, and monitoring equipment; conditions under which they will be used; and verification

of condition of equipment
(6) Designation of frequency and type of atmospheric monitoring
(7) Designation of controls required (e.g., lockout/tagout, ventilation, etc.)
(8) Procedures for communication during confined space operations

c. All confined spaces shall be tested by a qualified person using a properly calibrated monitor for percent oxygen, lower explosive limit (LEL), and toxicity each time before entry and periodically during operations that have the potential to alter atmospheric conditions. Supervisors shall contact 7 BW/SEG when these or any other entry conditions are not consistent with the MEP.

4.6 Additionally, other special considerations which may apply such as speed limits in MFH, vehicles with catalytic converters operating within 50' of aircraft, work being performed in explosives clear zones, equipment disposition in the Munitions Storage Area (MSA) during and after work hours, etc. For most conditions FAR 52.236-13 Accident Prevention, which Contracting will include by reference, will be sufficient. A paragraph on "Airfield Safety Precautions," DFARS 252.236-7005, should automatically be included by reference by Contracting in the General Provisions of applicable airfield construction contracts. Verify the FAR references to avoid duplication. Resolve with Contracting if in doubt.

5. STREET CLOSINGS: ***(Use only when required)***

5.1 One lane of traffic shall be maintained at all times unless otherwise approved in writing by the Contracting Officer.

5.2 Contractor shall provide 14-day advance written notice to Contracting Officer prior to any street closures to insure that Fire Department and Emergency personnel are notified.

5.3. The final street repair shall be completed within 14 days after the start of any street demolition for utility crossings or other purposes. Any part of the street returned to service prior to final repair shall be maintained smooth with hot-mix cold-lay surface course.

5.4 Special note to Designers: Utilities are covered under Section 00 01 03. Also, IAW 05 May 97 HQ ACC/CE policy; trenching and excavation of pavements will be curtailed to the maximum extent possible. The recommended method for utility installations crossing streets, sidewalks, curbs, or gutters is trenchless boring or jacking. Excavations must be kept to an absolute minimum and used in those rare cases; such as repair of existing utility lines and solid obstructions, which preclude the use of boring technology. A separate special specification section is normally required for jacking and boring.

6. DISPOSITION OF WASTE, EXCESS, SCRAP, AND SALVAGE MATERIALS: The title to all waste, excess, scrap, and salvage materials generated as a direct result of this contract is vested in the Contractor - unless specifically excepted below. Further (unless listed below in exceptions), these materials shall be disposed of off the Base by the Contractor in accordance with all applicable Federal, State, and Local Regulations. Following is a list of materials (Exceptions) that will be generated as a result of this contract and shall be turned-in to the Government at a location at Dyess AFB designated by the Contracting Officer:

Exceptions: Government will salvage existing fire alarm panel & BTXM2 transceiver.

7. STORAGE AREA (I.E. TEMPORARY FIELD OFFICE, STAGING AREAS, TOOL/JOB SHACKS, AND OTHER CONSTRUCTION FACILITIES): There are no Government furnished covered or secure storage areas. Limited on-base, off-site storage will be permitted on a space available basis. The location on Dyess AFB of the Contractor's temporary field office, storage, and other construction buildings required temporarily in the performance of the work, shall require written approval of the Contracting

Officer. Plans showing temporary field office, storage, and other construction buildings shall be submitted for approval (GA) of the Contracting Officer. Utilities at the storage area may or may not be available for Contractor use. The Government implies no responsibility for lost or stolen materials, equipment or tools, the security of which lies solely with the Contractor. Contractor shall keep their storage areas clean, neat and orderly and will keep grass mowed to a maximum height of 4 inches. Temporary fencing used by the Contractor to delineate constructor sites shall be securely anchored with tension wires and posts as required to prevent sagging and an unsightly appearance. Fencing shall be maintained by the Contractor in this manner throughout the life of the contract. Due to high winds in West Texas, Contractor shall take every precaution to preclude trash from blowing off site.

7.1 CONSTRUCTION AREA & CONTRACTOR LIMITS OF CONSTRUCTION: Contractor shall keep their construction areas clean, neat and orderly and will keep grass mowed to a maximum height of 4 inches.

8. TOILET FACILITIES:

8.1 There are no toilet facilities available for Contractor use. Contractor shall provide his own portable/temporary toilet facilities.

9. CLEAN-UP: The Contractor shall at all times keep the construction site and storage area(s) free from accumulation of waste, rubbish, or construction debris. All loose or lightweight materials shall be secured to prevent blowing or scattering. The burning of trash or construction debris is strictly prohibited on Dyess AFB. Prior to final inspection, the Contractor shall remove all construction debris, tools, equipment, and materials not the property of the Government. Upon completion of the work, the Contractor shall leave the work site and storage area(s) in a clean, neat and workmanlike condition satisfactory to the Contracting Officer.

10. INSPECTIONS:

A. Above Ceiling Inspection: The Contractor shall advise the Contracting Officer of the Contractor's desired above ceiling inspection date seven (7) calendar days in advance of that desired date to permit proper coordination.
B. Final Inspection: The Contractor shall advise the Contracting Officer of the Contractor's desired final inspection date seven (7) calendar days in advance of that desired date to permit proper coordination. The date selected shall provide adequate time for Contractor performed corrections of final inspection deficiencies within the contract performance time. The Contracting Officer will be the final authority for determining whether or not the Contractor's performance is sufficiently advanced to warrant a final inspection.

11. TESTING: Costs of all tests, unless specifically indicated as being performed by the Government, will be at the Contractor's expense. It is the responsibility of the Contractor to schedule all tests and to notify the Contracting Officer or his representative in a timely manner prior to any required testing. All test results shall be submitted to the Contracting Officer on AF Form 3000, Material Approval Submittal.

12. AS-BUILT DRAWINGS, INSTRUCTION MANUALS, AND TRAINING:

12.1 As-Built Drawings: Refer to Section 01 78 00. The Contractor shall maintain two sets of project drawings for "as-built" notations and marking. The Contractor shall update these plans to indicate "as-built" construction and shall submit them to the Contracting Officer prior to final inspection under the cover of an AF Form 3000. Updated notations and markings shall be neat, clear, and legible in all respects.

12.2 INSTRUCTION MANUALS (O&M Data): Refer to Section 01 78 23. Required instruction

manual(s) shall be provided in three ring binder(s) with tabs and an index/table of contents. Provide permanent label on front and side with project title, project number, facility number, street address, Contractor/Subcontractor name, address, phone number(s), and manual title/contents description. Include all wiring diagrams and parts lists. Manuals shall be submitted to the Contracting Office for approval prior to Final Inspection.

12.3 TRAINING REQUIREMENTS: Provide training for government operating and service personnel in the proper operation of contractor furnished equipment. Schedule training time(s) with Contracting Officer to permit maximum participation by government personnel. Each instruction or training period shall be video taped by the Contractor and files will be submitted to the Government in WMV, MPEG, or MP-4 format on a CD/DVD. The taping shall include the entire session(s). The original CD/DVD video(s) shall be labeled and turned over to the Contracting Officer shall be of a quality to enable clear and understandable playbacks of the recorded events.

13. SECURITY REQUIREMENTS:

Dyess AFB security may be viewed as being one of three broad levels, the level in effect being dependent on the location or AREA of Dyess AFB in question.

a. The lowest level of security exists in GENERAL ACCESS AREAS. These AREAS are all of Dyess AFB outside of the "USAF Controlled" and "USAF Restricted" AREAS.

b. USAF Controlled Access AREAS are the mid-level security AREAS. Presence within the CONTROLLED ACCESS AREA is by authorization; however, the movement of authorized personnel in and out of these AREAS is generally not impeded. Contractor personnel are given access to these AREAS.

c. The third and highest level of security on Dyess AFB is that within the USAF RESTRICTED AREAS. These AREAS are further subdivided to be known as Protection Level 1, 2 or 3 AREAS.

13.1 Referencing the above, the work on this contract will be identified in the SOO/SOW.

13.2 Requests for changes to the work schedule for work in USAF restricted areas, must be submitted a minimum of 7 calendar days in advance for approval and coordination of Dyess AFB Security Forces.

13.3 Dyess Air Force Base is a closed base. All personnel entering must have specific permission of the installation commander for entry. This permission is granted when a Contractor employee is issued an identification card. Information necessary to obtain identification cards will be provided by the Contracting Officer at the pre-performance conference. The Contractor shall be responsible to ensure that all of its employees obtain, and keep on their person at all times while working on the base, a USAF identification card. Upon completion of the work or termination of an employee, the Contractor shall be responsible for turn in of identification cards no longer needed to the Contracting Officer or to the Pass and Registration Office of the Security Forces. Failure to turn in badges will result in last payment of payroll to be withheld and revocation of any future badges issued by Pass and Registration Office to the employee and the contractor.

14. IDENTIFICATION OF CONTRACTOR VEHICLES: **Contractor vehicles must be marked on each side with company name with either permanent or semi-permanent / magnetic signage.**

15. WARRANTIES: Any warranties given to the Contractor or sub-Contractor at any tier from a manufacturer of equipment or other items which are provided under this contract shall be transferred to

the Government upon final acceptance. Contractor shall submit in writing a single listing with all applicable warranties attached.

16. SUBMITTALS:

16.1 Required Submittals: All submittals required by the Contract Documents shall be submitted for approval to the Contracting Officer. Use a completed AF Form 3000 as a transmittal document. Where a submittal cannot be provided within the required submission date, Contractor shall submit in writing a letter stating the reasons why and furnishing a new projected submission date. **All Material Submittals (Form AF 3000) and all submittal data shall be submitted electronically. All pdf's shall be created from original electronic documents, no scans allowed due to file size, unless otherwise approved.**

16.2 Variations/Deviations/Departures from the Contract Documents: Contractor proposed variations, deviations or departures from the contract requirements shall be noted/marked in red on each copy of the submittal data and shall be provided with a letter attachment to the AF Form 3000 summarizing the proposed variation, deviation, or departure. **Variations, deviations, or departures shall contain sufficient information to permit complete evaluation.** Additional sheets may be used to fully explain why a variation, deviation, or departure is requested. The Government reserves the right to disapprove or rescind inadvertent approval of submittals containing unnoted/unmarked/not-clearly-defined variations, deviations or departures.

17. INSURANCE REQUIREMENTS

17.1 For the purpose of this FAR 52.228-5 the following minimum limits are provided**:**

17.2 **Workmen's Compensation and Employers Liability Insurance** as required by law except if this contract is to be performed in a State which does not require or permit private insurance, then compliance with the statutory or administrative requirements in any such State will be satisfactory. The required Workmen's Compensation insurance shall extend to cover employer's liability for accidental bodily injury or death and for occupational disease with a minimum liability limit of **$100,000.**

17.3 **General Liability Insurance**. Bodily injury liability insurance, in the minimum limits of **$500,000** per occurrence shall be required on the comprehensive form of policy.

17.4 **Automobile Liability Insurance.** This insurance shall be required on the comprehensive form of policy and shall provide bodily injury liability and property damage liability covering the operation of all automobiles used in connection with the performance of the contract. At least the minimum limits of **$200,000** per person and **$500,000** per occurrence for bodily injury and **$20,000** per occurrence for property damage shall be required.

18. INVESTIGATION OF DAMAGE OR INJURY

18.1 The United States Government will have the right to conduct an investigation, or participate in the contractor's investigation, of any damage or injury to United States Government property, equipment or personnel.

19. CONTRACTOR RESPONSIBILITY

19.1 Contractors operating on base shall be responsible for briefing and ensuring their employees adhere to the traffic rules and regulations. The foreman, job supervisor, and other personnel providing workman leadership will, when possible, ensure the workers comply with these rules and regulations. Speed limit on base is 30 MPH unless otherwise posted. The speed limit in base housing areas is 20 MPH and the

speed limit in parking lots is 5 MPH. The school zone speed limit is 5 MPH. Individuals are to obey all entry procedures. If instructions are given by the Security Forces personnel on the entry points (gates), they will be complied with immediately. Security Forces utilize speed detection devices and citations will be issued to violators. Personnel who park on grass or seeded areas will be cited.

20. CONSTRUCTION EQUIPMENT

20.1 Equipment and vehicles to be used on base shall be safe and in good operating condition. The Contracting Officer, or authorized representative, reserves the right to inspect any on-base equipment and reject such equipment if he/she considers it unsafe, in poor operating condition, or inappropriate for work. Contractor must notify the Contracting Officer of any contractor equipment that is broken down on Dyess AFB roads. Every effort should be made to move broken down equipment to the nearest parking lot before leaving it.

21. GOVERNMENT LIABILITY

21.1 The Government shall not be liable for any loss or damage to the contractor's property, including stock, or for expense incidental to such loss or damage.

22. TELEPHONE COMMUNICATION SECURITY MONITORING

22.1 All communications with DOD organizations are subject to communications security (COMSEC) review. Contractor personnel will be aware telephone communications networks are continually subject to intercept by unfriendly intelligence organizations. The DOD has authorized that military departments conduct COMSEC monitoring and recording of telephone calls originating from, or terminating at, DOD organizations. Therefore, civilian contractor personnel are advised any time they place a call to, or receive a call from, a USAF organization, they are subject to COMSEC procedures. The contractor will assume the responsibility for ensuring wide and frequent dissemination of the above information to all employees.

**** END OF SECTION ****

PART 1 – GENERAL

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

2. IDENTIFICATION: THE GOVERNMENT DOES NOT KNOW THE LOCATION OF UTILITIES IN THE WORK AREA. Accordingly, the Contractor shall be SOLELY RESPONSIBLE for locating and marking the exact location of all existing utilities within the contract work area prior to any excavating, trenching, backfilling or disturbance. The Contractor is SOLELY RESPONSIBLE for any and all damage to existing utilities in the contract work area. Upon request by the Contractor, the Government shall furnish all available information in its possession concerning utilities in the contract work area. However, the accuracy of the information provided by the Government is not guaranteed and is only intended to provide some measure of assistance to the Contractor. The Contractor shall call 7 CS/SCOIT at 696-8065 a minimum of five (5) calendar days in advance to have underground communications cable routes marked. Base Civil Engineering does not have nor shall it provide record drawings of Bell Telephone cable plant. In the event the Contractor identifies utilities in the contract work area which interfere with the newly proposed construction, the Contracting Officer shall be immediately notified and the Government shall take necessary corrective action at no cost to the Contractor. The Contractor shall furnish to the Contracting Officer as-built drawings clearly identifying the exact location of all utilities identified in the work area prior to project final inspection.

2.1 Contractor must initiate a Work Clearance Request AF Form 103 (digging permit) from 7 CES/ CEPM a minimum of seven (7) calendar days prior to the start of any construction work. Excavation is not authorized without issuance of a completed and approved AF Form 103. After initial issue, it is the Contractor's responsibility to keep the Work Clearance Request coordinated and up-to-date/current through the remainder of the contract.

2.2 Any removal/relocation/reconnection of any communication device shall be coordinated in advance with 7 CS/SCOIT at 696-8065. Any removal/relocation/reconnection of any Cable TV device shall be also be coordinated in advance with 7 CS/SCOIT (ask for the NCOIC of Cable TV) at 696-2400. Communications and Cable TV devices to remain shall be protected as required when work proximity dictates.

2.3 Any removal/relocation/reconnection of any fire protection device or intrusion detection systems shall be coordinated in advance with 7 CES/CEOFE at 696-5184. Any removal/relocation/reconnection of any security system should be coordinated with 7 SFS/S5C at 696-8523.

2.4 The locating and marking devices utilized by the contractor for existing utilities or proposed work shall be 2” wooden stakes with multicolored whiskers 4” to 6” in length.

2.5 **Exposed Existing Utilities: When existing utilities to remain are exposed, the Contractor shall contact the Contracting Officer and 7 CES Geobase Shop to survey any exposed utility line or feature below the surface. In addition, when new utility lines are installed or constructed, the Contractor shall contact the Contracting Officer and 7 CES Geobase Shop to survey all utility features below the surface. The Contracting Officer and 7 CES Geobase Shop must be contacted 5 days prior to the utility lines being back-filled. 7 CES Geobase Shop may be contacted at 325-696-5630. The Contractor will be responsible for any additional costs for exposing new utility lines that have not been surveyed by 7 CES Geobase Shop.**

3. INTERRUPTIONS:

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

3.2 Unplanned Utility Outages (Accidental Disruption of Utilities): In the event of accidental disruption of any utility, the Contractor shall immediately notify the Contracting officer of the unplanned outage. The Contractor shall immediately take every reasonable step to repair the damage in a manner acceptable to the Government and will restore the utility to full use as soon as practicable. If the Contractor so desires, and the Government agrees, the Government may complete necessary repairs to the damaged utility and withhold from payments due to the Contractor the necessary amount to defray all costs associated with the repair of the utility.

4. USE: All reasonable quantities of existing utilities will be made available to the Contractor without charge. Any temporary connections or lines required shall be installed, maintained, and removed at the Contractor's expense. Any damage associated with the use of these utilities shall be repaired and/or replaced in a manner satisfactory to the Contracting Officer at Contractor's expense. See Contractor Request for Use of Dyess AFB Fire Hydrants included in this Section.

The following information must be prepared and forwarded, on AF Form 3000, Material Approval Submittal, to the CO for approval and coordination with Civil Engineering.

Request For Utility Outage

From: _____

Contract No:_____**Description and Location of Contract**: _____

Date of Outage Requested:_____**Type of Outage**:_____

Location Affected by Outage:

Description of Work to be performed and Other Utilities Affected:

Requested Civil Engineer Support:

Date:_____ Time:_____

Type of Support:

Electrical X-5184_____ Water X-4481_____

Access X-4155_____ Road Closure X-4155_____

Alarms X-5195_____ Fire Dept Standby X-4930_____

Duration of Outage: Start:_____ Completed:_____

Signature:

_____ _____
Contractor Representative: Date:

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

Contractor Request for Use of Dyess AFB Fire Hydrants.

Project Title _____

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

a. The company providing a suitable connection with a Class III Back Flow Preventer (reduced pressure principle device) and screw type globe valve to be attached to the hydrant. The connection will be 2 1/2" National Standard fire thread. The backflow device and valve shall be installed prior to hydrant use & properly supported to prevent damage to fire hydrant threads.

b. Call the Water Shop for certification of your backflow device **PRIOR TO INSTALLATION** at 325-696-1807. Non-compliant devices will be removed without notice.

c. Backflow preventers shall be installed with the vent facing down & at least 12" clearance below the unit.

d. Leaving the connection in place during approval period.

e. Insuring the hydrant is fully opened and left in that position during approval period, except in periods of freezing weather. **If hydrant is closed, it must be RECERTIFIED prior to reopening.**

f. Insuring an approved fire hydrant wrench is used to open/close the hydrant.

g. Insuring all servicing from the hydrant is done at the top of the vehicle or tank. No bottom servicing will be permitted.

h. Using no quick opening valves causing excess water hammer in the main.

i. Discontinuing hydrant use if there is any hydrant malfunction or leakage from underground and reporting same to the Fire Department, 696-2486.

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

_____ _____
(Signature) (Date)

_____ _____
(Print Name) (Print Title)

**** END OF SECTION ****

PART 1 – GENERAL

1. APPLICABLE ENVIRONMENTAL REGULATIONS, LAWS, AND PUBLICATIONS: In accordance with (IAW) Executive Orders (EO) 13101, 13123, 13134, and 13148, federal, state, and local environmental protection laws, Dyess Air Force Base (DAFB) is committed to the principals of "Leadership in Environmental Management" and "Greening the Federal Government." In addition, DAFB implements EO 13045, 13229, and 13296, to ensure protection from environmental health and safety risks. The specifications and standards contained in this section are to ensure that DAFB meets the mandates as established by statute and EOs, as well as Environmental Protection Agency (EPA), Department of Transportation (DOT), Occupational, Safety and Health Agency (OSHA), and Department of Energy (DOE) policy and guidance.

1.1. ENVIRONMENTAL PROTECTION STANDARDS: The following list serves as the basis for standards of environmental protection for work accomplished on DAFB:

- The Resource Conservation and Recovery Act authorized Comprehensive Procurement Guidelines (CPG),
- The National Technology Transfer and Advancement Act/OMB Circular A-119,
- DOE's Federal Energy Management Program Product Efficiency Recommendations,
- EPA's Waste Minimization Priority Chemicals,
- EPA's Indoor Environments Program Recommendations, and
- EPA's Construction Industry Compliance Assistance Center Recommendations.

1.3. ENVIRONMENTAL GOALS:

1.3.1. General:

1.3.1.1. Resource Management: Promote stewardship of the earth's resources. The earth's resources include: perpetual resources, renewable resources, and non-renewable resources. Preserve or renew biodiversity and ecosystems.

- Maximize use of bio-based and recycled content materials.
- Maintain or improve water quality and promote water stewardship.
- Employ job-site recycling and salvage procedures.
- Employ DfE methodologies.

1.3.1.2. Toxicity/IEQ: Promote good indoor environmental quality (IEQ). Aspects of IEQ include: light quality, acoustic quality, and air quality.

- Utilize a precautionary approach.
- Maximize use of non-toxic, non-hazardous, healthy, and safe building materials.

1.3.1.3. Performance: Promote efficiencies in operational performance. Aspects of operational performance include: durability, maintainability, energy efficiency, and water efficiency.

1.4. CONTRACTOR'S ENVIRONMENTAL MANAGER: The Contractor shall designate an onsite party responsible for overseeing the environmental goals for the project and implementing procedures for environmental protection.

1.4.1. Qualifications: Minimum 5 years construction experience on projects of similar size and scope; minimum 2 year's experience with environmental procedures similar to those of this project; familiarity with Environmental Management Systems (EMSs) such as ISO 14001; and familiarity with environmental regulations applicable to construction operations.

1.4.2. Responsibilities: The Contractor's environmental manager shall ensure:

- Compliance with applicable federal, state, and local environmental regulations, including maintaining required documentation.
- Implementation of Contractor's environmental protection plans prepared IAW EPA EMS or ISO 14000 standards.
- Training for Contractor personnel IAW their position requirements, and shall include at a minimum, an overview of environmental issues related to the building industry and overview of environmental issues and regulations related to the project.

1.5 CONFORMANCE with ENVIRONMENTAL MANAGEMENT SYSTEMS:

The Contractor shall perform work under this contract consistent with the relevant policy and objectives identified in the agency, organizational, or facility environmental management system (EMS) applicable for your contract. The Contractor shall perform work in a manner that conforms to all appropriate Environmental Management Programs and Operational Controls identified by the agency, organizational, or facility EMS, and provide monitoring and measurement information as necessary for the organization to address environmental performance relative to the environmental, energy, and transportation management goals. In the event an environmental nonconformance or noncompliance associated with the contracted services is identified, the contractor shall take corrective and/or preventative actions. In the case of a noncompliance, the Contractor shall respond and take corrective action immediately. In the case of a nonconformance, the Contractor shall respond and take corrective action based on the time schedule established by the EMS Site Coordinator. In addition, the Contractor shall ensure that their employees are aware of the roles and responsibilities identified by the environmental management system and how these requirements affect their work performed under this contract.

All Contractor employees must complete Air Force provided initial EMS awareness-level training. The COR needs to ensure the contractor and their employees complete the training prior to work start and maintain a list of completion in the contract folder for accountability and inspection. The following steps need to be completed by the contractor in order to logon and complete the required training:

To access and register to the ESOH Training Network:

Go to www.esohtn.com

Click on the 

to enter, then

Find the Registration box on the bottom right side of the screen.

Type into the Registration Password box

esohtn

Click on Create an Account, and Follow the instructions on each screen to complete each step of the registration process all blocks with an "*" must be filled.

Step 1. First and Last Name and email address

Step 2 Account information User Id and password

Step 3 User Type: Select "Construction Contractor "or "Non-Construction" Next

Step 4 Organization information, Select "Dyess AFB", for your company name if listed, if not listed

Select "Company not Listed". Select contractor number if applicable—Next.

Step 5 Under Job Functions select "Environmental Requirements for Contractors (Mandatory for all Installation Contractors)" Next

Step 6 Select "I agree"

Step 7 Select "Go To Training"

Step 8 Select "Go to my Training Modules"

Step 9 Select "Go to training" and complete training, complete test and print certificate

When training is complete, forward certificate to the Contractor.

PART 2 – RESOURCE PROTECTION

2. PROTECTION OF RESOURCES: Construction, renovation or demolition activities are not exempt from air emission, storm water, hazardous waste, and other environmental compliance, environmental protection or pollution prevention rules and regulations. Contractor shall investigate, comprehend, and comply with all environmental rules and regulations applicable to his chosen method of accomplishment of the work under this contract.

2.1. PROTECTION OF LAND RESOURCES: The Contractor shall confine his construction activities to areas defined by the plans or specifications. Except in areas to be cleared, do not remove, cut, deface, injure or destroy trees or shrubs without the CO's approval. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorage unless authorized by the CO. Where such use of ropes, cables, or guys is authorized, the Contractor shall be responsible for any resultant damage.

2.1.1. Restoration or Replacement of Landscape Damage: Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense. The CO will decide what method of restoration shall be used, and whether damaged trees shall be treated or removed and disposed of under requirements for clearing and grubbing. If damaged trees are to be removed, they are to be replaced with equivalent, undamaged trees and landscaping features at the Contractor's expense.

2.1.2 Topsoil and other Construction Fill Material from Off Base: Contractor must comply with the Federal Noxious Weed Act, as amended, 7 U.S.C. 2801-2814; 7CFR360: the Plant Protection Act (7 U.S.C. 7701 et seq.); 7 U.S.C. 7701-7772 and 7781-7786; 7 CFR 2.22, 2.80, and 371.3; and Executive Order 13112, Invasive Species. The Contractor shall not introduce any invasive or noxious weed identified on the latest Federal Noxious Weed List (Federal Noxious Weed Act of 1974), the Texas Administrative Code (TAC) Quarantines and noxious plants, Chapter 19 (24 May 2006). State of Texas; the DAFB Integrated Natural Resources Management Plan, Chapter 7.12, Invasive Species Management.

2.1.3. Post-Construction Cleanup or Obliteration: The Contractor shall obliterate all evidence of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess materials, or any other vestiges of construction. It is anticipated that excavation, filling, and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be graded and filled as required, and topsoil shall be spread to a depth of approximately three inches over the entire area and the entire area seeded with at least two pounds (pure live seed) of common Bermuda per 1,000 square feet

and then watered as required until a lush hardy growth is established to the satisfaction of the CO. Restoration to original contours is required unless otherwise directed by the CO.

2.2. PROTECTION OF THE STRATOSPHERIC OZONE: The Contractor shall comply with Title 40 of the Code of Federal Regulations, Part 82 (40 CFR Part 82). To the maximum extent practicable, the Contractor shall utilize safe alternatives and products made with, or containing, safe alternatives to Class I or II ozone depleting substances (ODS) identified in 42 U.S.C. 7671K. A Class I ODS is defined in section 602 (a) of the Clean Air Act (CAA) and includes the following chemicals:

CFC-11	CFC-12	CFC-13	CFC-111	CFC-112
CFC-113	CFC-114	CFC-115	CFC-211	CFC-212
CFC-213	CFC-214	CFC-215	CFC-216	CFC-217
halon-1211	halon-1301	halon-2402	carbon tetrachloride	methyl chloroform

2.3. PROTECTION OF HISTORICAL AND ARCHAEOLOGICAL RESOURCES: All known historical, archaeological, and cultural resources, if any, within the Contractor's work area will be designated on the contract drawings. The Contractor shall take precautions during the contract to preserve all resources as they existed at the time of contract award and comply with the National Historic Preservation Act (NHPA), 36 CFR 60-61 and 800-812; and Native American Graves Protection and Repatriation Act (NAGPRA), 43 CFR 10. The Contractor shall provide all protective devices such as off-limit markings, fencing, barricades or other devices as designated on the contract drawings and shall be responsible for preservation of the sites during this contract.

2.3.1. Recording and Preserving Historical and Archaeological Finds: All items having any apparent historical or archaeological interest outside of designated areas that are discovered in the course of any construction activities shall be carefully preserved. The Contractor shall protect the find in-place by leaving the archaeological find undisturbed and by using flags to mark a 50-foot radius area around the find. The find shall be immediately reported to the CO so that the proper authorities may be notified. All work shall be stopped in the immediate area of the discovery until directed by the CO to resume work. Any work required to preserve or protect these finds shall be accomplished before work resumes.

2.4 . PROTECTION OF WATER RESOURCES: The Contractor shall not pollute streams, tributaries, lakes, or reservoirs with substances including, but not limited to, fuels, oils, bitumen, calcium chloride, acids, construction wastes, contaminated storm water runoff, or other harmful materials identified in 40 CFR Parts 117 and 302. It is the responsibility of the Contractor to investigate, comprehend, and comply with all applicable federal, state, county, and municipal laws concerning pollution of rivers and streams--particularly the Clean Water Act (CWA), 33 CFR 151-158 and 320-338, 40 CFR 15, 20-25, 100-149, 220-233, 400-471, 501, and 503, and 49 CFR 130; Federal Water Pollution Control Act (FWPCA), National Contingency Plan (NCP), and Oil Pollution Act (OPA), 30 CFR, 33 CFR, 40 CFR, 46 CFR, and 40 CFR; Safe Drinking Water Act (SDWA), 40 CFR 141-149 and 42 CFR 50, 59, and 124; Pollution Prevention Act (PPA), 40 CFR 370-372; Texas Drinking Water Standards, Title 30 of the Texas Administrative Code, Part 290 (30 TAC 290); and the Texas Water Code, 30 TAC 205,216, 220, 279, 305, 307-308, 311-312, 314, and 321. All work under this contract shall be performed in such a manner that objectionable or nuisance conditions will not be created in lakes, reservoirs, or streams through or adjacent to the project areas. For construction sites of one (1) acre or more, and at least 30 days prior to the start of construction, the Contractor shall prepare a storm water pollution prevention plan (SWP3) and file with Texas Commission on Environmental Quality (TCEQ) a Notice of Intent (NOI), TCEQ-20022 (02/03) or successor form. The construction site notice specified in the Texas Pollutant Discharge Elimination System General Permit (TPDES GP) for Part II.D.2 shall be posted as specified in the permit. Construction activities that start on or after 15 December of one year and are completed in all respects, including final stabilization, by 14 February of the next year may utilize low rainfall erosive waiver provisions of the TPDES GP, which do not require a SWP3, but do require submittal of an NOI to TCEQ using TCEQ-20064 (02/03) or successor form, and posting of a construction notice for Part II.D.1 of the

GP. Contractor shall submit a Notice of Termination (NOT) as required by the GP using TCEQ-20023 (02/03) or successor form. Contractor shall perform notifications as required by the GP. There shall be no fill, to include trees and vegetation, placed in a wetland or water of the U.S. as they are defined by the CWA or the 1987 Corps of Engineers Wetlands Delineation Manual. Wetlands and/or possible wetlands in the work area will be delineated prior to awarding of the contract. The Contractor shall be aware of CWA Section 404 requirements and permits and shall be responsible for compliance. Vehicles shall not pass through wetlands unless absolutely necessary, and mats will be placed on the area for protection prior to driving. Certain documents must be prepared, filed, and/or posted as generally outlined in the table below and specifically stated in the TPDES GP:

Site Size, Acres	***Low Erosive Provision Applies***	***Notice of Intent (NOI) Required***	***Storm Water Pollution Prevention Plan (SWP3) Required***	***Construction Site Notice (CSN) Required***	***Notice of Termination (NOT) Required***	***Provide to MS4***
< 1	***N/A***	***No***	***No***	***No***	***No***	***N/A***
1 - < 5	***Yes***	***No***	***No***	***Yes***	***No***	***CSN***
1 - < 5	***No***	***No***	***Yes***	***Yes***	***No***	***CSN***
> = 5	***No***	***Yes***	***Yes***	***Yes***	***Yes***	***NOI, NOT***

2.4.1. Erosion Control: The Contractor shall control erosion and disposing of wastes. Surface drainage from cuts and fills within the construction limits, whether or not completed, and from borrow and waste disposal areas, shall, if turbidity producing materials are present, be held in suitable sedimentation ponds, or the areas shall be graded to control erosion within acceptable limits. Temporary erosion and sediment control measures such as berms, dikes, drains, or sedimentation basins, if required to meet the above standards, shall be provided and maintained until permanent drainage and erosion control facilities are completed and operative. The area of bare soil exposed at any one time during construction operations shall be held to a minimum. Unless otherwise approved by the CO, the Contractor shall apply, as soon as practicable, an approved, temporary mulch on denuded ground. This shall apply to all areas not subject to appreciable traffic during construction, including areas that are to receive some form of construction later, if ground is to be exposed 60 days or more. Stream crossing by fording with equipment shall be limited to control turbidity and in areas of frequent crossings temporary culverts or bridge structures shall be installed. Any temporary culverts or bridge structures shall be removed upon completion of the project. Fills and waste areas shall be constructed by selective placement to eliminate to the extent practicable silts or clays on the surface that will erode and contaminate adjacent streams or lakes.

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

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

2.4.2.2. Form: The Contractor shall use the most current CSI certificate form found in Title 30 290.47(d) of TAC. See paragraph 4.3 of this section for submittal of certificate form.

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

2.5. PROTECTION OF FISH AND WILDLIFE: The Contractor shall follow all federal, state, county and municipal laws regarding the protection of fish and wildlife--particularly the Migratory Bird Treaty Act (MBTA) 16 U.S.C. 703-712, Endangered Species Act (ESA), 7 CFR 355-356 and 50 CFR 17, 23-24, 81, 217, 222, 225-227, 402, 424, 450-453, and 31 TAC 65 & 69. The Contractor shall at all times perform all work and take such steps required to prevent any interference or disturbance to fish and wildlife. The Contractor shall not alter water flows or otherwise disturb native habitat adjacent to the project area which, in the opinion of the CO, are critical to fish or wildlife. Construction of check dams in live streams will not be permitted. Fouling or polluting of water will not be permitted. Wash waters shall be processed, filtered, ponded, or otherwise treated prior to their release into a river or other body of water. The CO must approve the release of any wash waters or waste waters into a river or other body of water prior to the release of any wash waters or waste waters.

2.6. PROTECTION OF AIR QUALITY: It is the responsibility of the Contractor to investigate, comprehend, and comply with all applicable federal, state, county and municipal laws concerning air pollution, particularly the CAA, 40 CFR 50-95 and 30 TAC 101-122. Although the Contractor is responsible for complying with all rules/regulations associated with air quality, the requirements must be coordinated through 7 CES/CEIE (all registrations, permits, hourly/daily/weekly/monthly records, MSDSs, notices, etc.) prior to the start of any construction/demolition/repair. All work under this contract shall be performed in such a manner that objectionable or nuisance conditions will not be created in the air nor will objectionable particulates be released to the air. No material shall be burned on DAFB.

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

2.7. SAFETY AND HEALTH PROTECTION: The Contractor shall comply will all applicable federal, state, and local laws and regulations to ensure protection of human health and safety IAW Occupational Safety and Health Act (OSHA), 20 CFR 1900-1990; and the Texas Health and Safety Code, 25 TAC et al.

2.8. WORKER, COMMUNITY, AND RIGHT-TO-KNOW PROTECTION LAWS: The Contractor shall comply with all applicable federal, state, and local laws and regulations to ensure worker and community right-to-know and protection requirements are met IAW the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 40 CFR 300-374; Emergency Planning and Community Right-To-Know Act (EPCRA), 40 CFR 355-372; Hazardous Materials Transportation Act (HMTA), 40 CFR 106-110 and 171-180; and Texas Hazards Communication Act, 25 TAC 295.

PART 3 - DISPOSAL OF WASTES, WASTE MINIMIZATION, AND EXCESS MATERIALS:

3.1. WASTE MANAGEMENT & MINIMIZATION: The Contractor shall manage waste generated IAW the Resource Conservation and Recovery Act (RCRA), 40 CFR 240-282; Texas Solid Waste Disposal Act, 25 TAC 1, 30 TAC 281, 305, 330, 333, and 335 (including Texas Waste Reduction Policy Act); ASTM D5792 and D5834, and ASTM E1609. The Contractor shall maximize source reduction, reuse, and recycling of waste from construction operations. At a minimum, the Contractor shall achieve a 50% ~~40%~~ diversion goal based on percent by weight of total solid waste diverted from landfill.

3.1.1. Waste Determinations: The Contractor shall make waste determinations for all wastes and excess materials directly generated in the performance of this contract, IAW the provisions set out in 40 CFR 261 - at the time and point of generation. The Contractor shall properly sample, analyze, or by use of process knowledge classify all wastes IAW 30 TAC 335, Ch R, at no additional cost to the Government. Unless it

is positively known by the Contractor that a waste is non-hazardous, the Contractor shall manage the waste as a hazardous waste until test results prove otherwise. All non-hazardous wastes, special wastes, and hazardous wastes (including but not limited to construction debris, material containers, material residues and unwanted excess materials) resulting from the performance of work under this contract shall be removed from and disposed of off DAFB by the Contractor at no additional cost to the Government and IAW all applicable federal, state, and local laws, rules and regulations. Under no circumstances shall the Contractor dispose of wastes or excess material in trash dumpsters, storm sewers, sanitary sewers, creeks, streams or other property of DAFB. The Contractor and the Government will be co-generators of all wastes resulting from the performance of this contract. The 7th Civil Engineer Squadron Environmental Section (7 CES/CEIE) will sign as generator on all waste manifests.

3.1.2. Non-Hazardous Wastes: Contractor shall transport and dispose of all non-hazardous wastes to and in a State of Texas-approved facility or other disposal facility approved by the state. 7 CES/CEIE will sign as generator on all waste manifests.

3.1.3. Special Wastes: Special wastes are any wastes that are non-hazardous yet have to be stored, transported, and/or disposed of in a special manner, i.e. petroleum contaminated soil (30 TAC 327) and asbestos (25 TAC 295 and 25 TAC 37). Contractor shall store, transport and dispose of all special wastes IAW all federal, state, and local laws, rules and regulations as applicable. Contractor shall dispose of special wastes in a State of Texas approved facility or other disposal facility approved by the state. Contractor shall make all necessary arrangements with the disposal facility of his choice for disposal of special wastes. Contractor shall prepare all necessary paper work, including but not limited to bill of lading, manifests, etc. at no additional cost to the Government. 7 CES/CEIE will sign as generator on all special waste manifests.

3.1.4. Hazardous Wastes: The Contractor shall be designated the “lead generator.” As such, the Contractor is required to notify the State of Texas, specifically the TCEQ, of the Contractor’s waste generating activities. The Contractor must have, or obtain, a Texas Solid Waste Registration (TSWR) number. Depending upon quantity/type of wastes, the TCEQ may also issue an EPA identification number concurrently with the TSWR number. The Contractor shall submit a copy of his initial notification package for hazardous waste management (Form Number TNRCC-00002) or, if already acquired, a copy of the TSWR number(s) assignment letter from the TCEQ to the CO as soon as possible after contract award.

3.1.4.1. The Contractor shall not perform any waste generation activities associated with the performance of work under this contract until he has actually acquired a TSWR number(s) and submitted it to the CO. Any ramifications (i.e. fines, penalties, etc.) resulting from waste generation activities without prior TCEQ notification/approval shall be the responsibility of the Contractor.

3.1.4.2. The Contractor shall strictly adhere to 30 TAC 305 and 335. The Contractor shall accumulate, manage, store, transport and dispose of all hazardous waste IAW 30 TAC 305 and Chapter 335. The Contractor shall maintain all records, shipping documents, training certificates, plans and other documents required and for the period specified in 30 TAC 305 and Chapter 335. Upon request by the Government, the Contractor shall provide a copy of any or all of the records, shipping documents, training certificates, plans and other documents required in 30 TAC 305 and Chapter 335 to the CO during the performance of this contract, or at any time during the record retention time as specified in 30 TAC 305 and Chapter 335.

3.1.4.3. The Contractor shall remove all hazardous waste from DAFB on a daily basis unless the accumulation and storage is specifically approved in writing by the CO and the 7 CES/CEIE. Such approval must be given prior to the generation of any hazardous waste. The Contractor’s attention is directed to the fact that approval for accumulation or storage of hazardous wastes equal to, or in excess of, 55 gallons for greater than three (3) calendar days will require a minimum lead time of forty-five (45) calendar days from the date of the receipt of the request and may not be approved. The Contractor shall transport hazardous wastes from DAFB to a Treatment, Storage, or Disposal (TSD) facility permitted by the State of Texas or other TSD facility permitted by the state in which the disposal facility is located.

Under no circumstances shall disposal or treatment of hazardous wastes (as defined in 30 TAC 335.1) be allowed on DAFB by the Contractor unless specified elsewhere in this contract.

3.1.4.4. The Contractor's attention is directed to the fact that violation or alleged violation of 30 TAC can and has resulted in the State of Texas issuing fines and penalties, both civil and criminal. As lead generator, the TCEQ and/or the EPA may, at any time and without notice, inspect the Contractor's operations and records for compliance with 30 TAC and/or 40 CFR 240-282. As co-generator, the Government will, as is deemed necessary, inspect the Contractor's operations and records for compliance with 30 TAC and 40 CFR 240-282. The Contractor shall cooperate fully with the TCEQ, EPA and/or Government representatives during these inspections, as applicable. The Contractor shall be fully and totally responsible for payment of all fines and/or penalties imposed by the TCEQ or EPA for violation of 30 TAC and/or 40 CFR 240-282, at no cost to the Government.

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

3.3. DISPOSAL CERTIFICATION: Contractor shall submit certification of proper disposal of all wastes to the CO prior to the Final Inspection.

PART 4 - SUBMITTALS:

4.1. ENVIRONMENTAL PROTECTION PLAN. Not less than 10 days before pre-construction meeting, the Contractor shall prepare and submit an Environmental Protection Plan including, but not limited to, the following:

(1) Identification of project;
(2) Identification and contact information for Environmental Manager;
(3) General site conditions;
(4) Summary of Plan;
(5) Procedures to address protection of water resources;
(6) Procedures to address protection of land resources;
(7) Procedures to address air quality;
(8) Procedures to address protection of natural resources; and
(9) Monitoring procedures.

4.2. MATERIAL/WASTE MANAGEMENT PLAN. Not less than 10 days before pre-construction meeting, the Contractor shall prepare and submit a Material and Waste Management Plan including, but not limited to, the following:

(1) List of the recycling facilities, reuse facilities, municipal solid waste landfills and other final disposition location(s);
(2) Identify materials that cannot be recycled or reused, and provide an explanation or justification;
(3) Identify materials to be purchased IAW EPA's Environmentally Preferable Purchasing Program; and to the maximum extent possible promote environmentally preferable purchasing during completion of this project; and
(4) Revise and resubmit Plan as required by Owner or as requested by TCEQ to demonstrate 50% ~~40%~~ solid waste diversion goal to landfill.

4.3. CUSTOMER SERVICE INSPECTION CERTIFICATE. Prior to acceptance of project, the Contractor shall submit for approval a CSI Certificate. The form as found at 30 TAC 290.47 (d) shall include be signed by an individual with appropriate credentials as found in paragraph 2.4.2.2.

4.4. FINAL DISPOSITION REPORT (FDR). Prior to final acceptance of project, the Contractor shall submit for approval a FDR. The report shall be signed by the owner of the Contractor's company or an officer of the company with the authority to act on behalf of the company. As a minimum, this report shall contain the following information:

(1) Report Summary [A summary of facilities completed under this contract, the contents of the FDR, and any special emphasis items such as loss of a manifest or clean-up of materials spilled during the construction]
(2) Chronology of Events [as occurred during project including placement of storm water controls, demolition waste generation, waste removal from site, waste disposal, asbestos abatement and disposal, major air upsets conditions, and other notable events which could impact the environment]
(3) Site characterization
  (a) Site conditions before contract start including general site drainage patterns, utility locations, facility site, jobsite trailer location, vehicle parking areas, material staging areas and access roads
  (b) Site conditions after contract completion including general site drainage patterns, facility site, jobsite trailer location, vehicle parking areas, material staging areas and access roads
(4) Closure activities
  (a) Field investigation of site conditions
  (b) Sampling Activities, including the sampler, equipment used, sample locations, packaging, and Chain of Custody documentation as applicable
  (c) Laboratory results, with Laboratory Quality Assurance and Quality Control (QA/QC) data and Method number as applicable
(5) QA/QC procedures
  (a) Confined space entry, as applicable
  (b) Waste Storage Activities including TCEQ waste generator identification number, equipment or methodology used for storage, container logs with wastes stored along with dates accepted as removed from storage and methods of control
  (c) Waste management & disposition including rinsates, residues, scrapings, waste piles, oil/water separator contents, etc.
  (d) Equipment decontamination including locations, materials used, disposition and disposal.
(6) References
  (a) Site location map with site characterization data
  (b) Site details including, material staging areas, waste storage locations, spill locations, sample locations, storm water controls, and air emission sources as applicable
(7) Documentation
  (a) Air Permitting Exemptions
  (b) Storm water Notice of Intent and Notice of Termination
  (c) Sample results
  (d) Signed and completed Waste Manifests
  (e) Waste destruction documentation
  (f) Container Logs
  (g) Chain of Custody documentation, as applicable
  (h) Plugging & Abandonment reports

(i) Disposal records, including landfill receipts, Contractor company owner certification pertaining to location of records, certificates of destruction, etc.

(8) Applicable photos, drawings, schematics of activities or processes

(9) Certification statement: with the following wording and signed by the owner of the company or an officer of the company with the authority to act on behalf of the company.

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

PART 5 - MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION:

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

PART 6 - PESTICIDES (INSECTICIDES, FUNGICIDES, HERBICIDES, ETC.):

Application of all pesticides shall be accomplished by certified pest control personnel in the category of treatment. Delivery and storage of pesticides will be monitored by certified personnel to ensure the adequacy of containers and the safe storage of toxic materials. With the exception of aerosol pesticides, disposal of pesticides and pesticide containers will be according to label directions. Disposal of containers and chemicals will be monitored to prevent pollution of natural drainage systems or the unintentional release of pesticide particulates into the air. Empty containers with a capacity of five gallons or less, with the exception of aerosol cans, may be disposed of in the general refuse dumpster. Contact 7 CES/CEIE for disposal instructions for empty containers exceeding a capacity of five gallons. Empty and non-empty aerosol cans must be containerized for disposal as a hazardous waste. Containers used for collecting empty and non-empty aerosol cans must be marked as "Pesticide Aerosol Cans" on a hazardous waste label. The Contractor shall comply with the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA), 20 CFR 1440 and 40 CFR 152-186; Texas Herbicide Law, 4 TAC 11; Texas Pesticide Control Act, 4 TAC 7 and 25 TAC 267; State of Texas Structural Pest Control Act, 22 TAC 591; and RCRA, 40 CFR 260 – 272 and 273.3. The Contractor shall submit copies of certifications for operator to CO and to the Pest Management QA for approval prior to application of insecticide, fungicides, and herbicides. Additionally, the DAFB Entomology Shop shall be notified at least three working days in advance by the Contractor of proposed application of any pesticides, insecticides, fungicides, herbicides, etc.

7. SPILLS: DAFB maintains, follows, and enforces the following plans regarding spills of classified substances, as contained in DAFB EPA One Plan: (NOTE: A spill is defined to include any spilling, overfilling, releasing, emitting, escaping, venting condition, leaking, air upset, or other discharge of a regulated substance. Regulated substances are listed in 40 CFR 117 and 302.)

- Hazardous Materials Emergency Response Plan
- Spill Prevention Control and Counter Measures Plan
- National Oil and Hazardous Substance Pollution Contingency Plan
- Community Right-To-Know Plan

7.1. PLAN LOCATION: These plans are maintained by 7 CES/CEIE, 710 3rd Street, DAFB. The Contractor shall take preventive measures (secondary containment, avoid overfilling of trucks, etc.) to avoid spills and if a spill were to occur, the Contractor shall immediately notify the DAFB Fire Department at phone number (325) 696-2117. The DAFB Fire Department is the first responder who will take charge to secure/neutralize the event and to coordinate cleanup/remedial actions. Notification shall be made even if spill is within the cleanup capabilities of the Contractor.

7.2. SPILL REPORTING: The Contractor shall report all spills immediately, as they occur, to permit proper response by DAFB and Contractor personnel. For example, spillage of asphalt into a field not intended to be asphalted, must be immediately cleaned up as the asphalt becomes a hazardous waste (no longer used for its intended purpose). Contractor shall be held liable for all expenses incurred by the Government during and after the spill response including but not necessary limited to spill pads, pillows, booms, vacuum truck and equipment rental, drums, waste transportation, laboratory analysis, and disposal costs.

8. CONTAINERS:

8.1. AEROSOL CANS: Aerosol cans, after use must be punctured and drained of product and propellant via approved equipment manufactured for that purpose. The empty cans then can be disposed of as ordinary household garbage or recycled. Disposal of the internal can contents shall be accomplished according to its waste classification.

8.2. OTHER CONTAINERS: Refer to 30 TAC 335.41/f for criteria regarding management and disposal of other containers.

~~***(Note to Designer: Include the following paragraphs nos. 9 thru 14 as applicable)***~~

9. ASBESTOS:

9.1 APPLICABLE LAWS, REGULATIONS AND REFERENCES:

9.1.1. 29 CFR 1910 and 1926, OSHA, US Department of Labor.

9.1.2. 40 CFR 61 (Amended), Subpart A and M, EPA.

9.1.3. 40 CFR 763, Subpart G and E, EPA.

9.1.4. 49 CFR Parts 172, 173, 177, and 178, DOT.

9.1.5. Texas Civil Statutes, Article 4477-3a (House Bill 36, 70th Legislature, 1987).

9.1.6. 25 TAC 295, Subchapter C, Texas Department of Health (TDH).

9.1.7. National Fire Protection Association (NFPA) Publication 70, National Electrical Code 2000.

9.1.8. All documents cited in 9.1.1 through 9.1.7 inclusive, shall be of the current edition including any changes, amendments, modifications or alterations thereto. The Contractor shall comply with all federal, state, and local regulations.

9.2. GENERAL:

9.2.1. All contract activities that have the potential of emitting asbestos shall be thoroughly controlled and work performed in accordance with all applicable federal, state, and local laws and regulations governing the occupational and the general public's exposure to asbestos material.

9.2.2. Furnish all labor, tools, materials, equipment, notifications, and insurance required to accomplish the removal and disposal of regulated asbestos containing materials (RACM) in accordance with the requirements of the EPA, OSHA, TCEQ, and TDH.

9.2.3. Furnish all labor, materials, equipment, permits, and insurance to transport RACM, in accordance with DOT regulations, to the BFI Regional Landfill North of Abilene, Texas.

9.3. SPECIFIC COMPLIANCE REQUIREMENTS:

9.3.1. The following are specifically applicable to work under this section.

9.3.1.1. 29 CFR 1910-(Amended) Subpart Z, para 1910.1001.

9.3.1.2. 29 CFR 1926-(Amended) para 1926.103, and 1926.1101.

9.3.1.3. 40 CFR 61, Subpart A, para 61.02.

9.3.1.4. 40 CFR 61 (Amended), Subpart M, para 61.141.

9.3.1.5. 40 CFR 763, Subpart G, para 763.121(b).

9.3.1.6. 25 TAC 295.31-295.73.

9.3.1.7. Texas Civil Statutes, Article 4477-3a, Section 1.

9.4. SUBMITTALS AND NOTICES:

9.4.1. Pre-Performance Submittals: The following information is required for submittal as stipulated in SECTION 1A, GENERAL.

9.4.1.1. Competent Person: The full name(s) and employee identification number(s) for the onsite and responsible competent person as defined by 29 CFR 1926.32(f) and 1926.1101.

9.4.1.1.1. Training Certification: The "Competent Person" shall have attended and successfully completed (by certification) an EPA approved course on the supervisory procedures and practices of asbestos abatement. All asbestos workers shall have attended and successfully completed (by certification) an EPA approved worker training course. A certified copy of the EPA approved course certificates shall be submitted.

9.4.1.1.2. License: The "Competent Person" shall submit a certified/notarized copy of their TDH license prior to commencement of work.

9.4.1.2. Asbestos Worker: The Contractor shall submit the names of all employees who are working as asbestos workers. A certified list of TDH registered asbestos workers shall be submitted prior to commencement of work. A copy of this list shall be present at the job site and available to Government inspectors. Additionally, a copy of the EPA approved "Asbestos Worker" course completion certificates shall be submitted for each of the employees named.

9.4.1.3. Laboratory Certification: Air samples collected shall be analyzed by a laboratory accredited by the American Industrial Hygienist Association (AIHA) and with successful participation in the latest round of the National Institute of Safety and Health (NIOSH), Proficiency Analytical Testing Program (PATP). Certified copies of the AIHA accreditation and NIOSH PATP shall be provided by each laboratory utilized to analyzed air samples.

9.4.1.4. Employee Training and Medical Surveillance: Documentation or certification that employees have received information, formal training and that a medical surveillance program is in effect for all employees in accordance with 29 CFR 1926.103. The Contractor shall submit a monitoring plan from a certified Industrial Hygienist to be utilized in employee, adjacent area and clearance monitoring for review and approval. (This monitoring plan shall be submitted at least ten (10) days prior to the initiation of any asbestos abatement project.) The air samples required under the approved monitoring program

shall be collected by a qualified independent third party to ensure the quality of the data collected and that proper work environments are maintained.

9.4.1.5. Facility Inventory: Prepare and submit a list detailing building and fixture conditions for approval by the CO.

9.4.1.6. Work Plan: Submit detailed work plan for the accomplishment of asbestos removal including critical barrier locations, negative air machine placement, shower and decontamination location, clean room, waste receptacle/dumpster placement, general direction of airflow through the space, and a description of how ACM wastes will be moved from containment and loaded into the receptacle. Plan shall also outline transportation requirements, and disposal. The plan shall also include, but not be limited to, the description of specific work practices and precautions to be taken to comply with the provision of 40 CFR 61, Subpart M, 40 CFR 763, and 29 CFR 1910 and 1926.

9.4.2. Other Submittals: The following information shall be maintained and copies submitted to the CO as stipulated below.

9.4.2.1. A daily log of all air samples collected and analyzed. The log shall be available for review by Government inspectors or the CO on demand. One copy of all the daily logs shall be provided not less than weekly to the CO. The log shall include the following information items:

(1) Date of sample collection.
(2) Location of sampling stations.
(3) Sample sequential number.
(4) Type of sample (whether personal or area).
(5) Method of air pump calibration with date and time of day for each daily calibration.
(6) Volume of air sampled (in liters)
(7) Results of analysis.
(8) The calculated time-weighted average (TWA).
(9) The name and time of entrance into and departure from the regulated area by persons.

9.4.2.2. All laboratory results shall be presented as original certified reports. All certified laboratory analytical results shall be submitted to the CO.

9.4.2.3. Provide one copy (to the CO) of all fully executed shipping manifest(s) of asbestos-containing wastes within fourteen calendar days after date of shipment. 7 CES/CEIE personnel will sign as generator on all manifests.

9.4.2.4. A copy of US Postal Service, PS Form 3811 (Return Receipt Request), shall be submitted for each notice required in paragraph 9.4.3. Notices. This US Postal Service form shall depict dates whereby compliance with the requirements of the regulatory agencies advance notification in calendar days can be confirmed by the CO.

9.4.2.5. The Contractor shall use BFI Regional Landfill, Abilene, Texas, exclusively for all disposal. The Contractor shall submit to the CO evidence that BFI will accept the quantity of RACM to be disposed of.

9.4.3. Notices:

9.4.3.1. The Contractor shall provide written advanced notice of intent to demolish or renovate facilities containing friable asbestos materials. An original notice shall be sent to each of the two regulatory offices listed below in compliance with the requirements of 25 TAC 295.61, and other applicable local, state, and federal regulations.

Texas Department of Health
4601 S. 1st Street, Suite L

Abilene, TX 79605, Ph (915) 795-5863

Texas Department of Health
Attn: Occupational Health Division/Asbestos Notification Section
1100 W. 49th St.
Austin, Texas 78756

Notices shall be prepared and postmarked or delivered within the required time frame. Demolition/renovation shall not commence until such notification time constraints have lapsed. **A copy of the notice, indicating dates original notices were sent to regulatory offices, shall be provided to the Contracting Office (7 CONS), Programs Flight (7CES/CEP), and the Environmental Section (7 CES/CEIE) 15 working days prior to the start date of asbestos abatement.**

9.4.3.2. Whenever a licensed asbestos Contractor proposes to engage in an asbestos abatement project, notification shall be made to the Texas Department of Health by a letter delivered not less than 20 days before such activities are to commence. (25 TAC 295.61) [40 CFR Part 61 (Amended), Subpart M, Para 61.145].

9.4.3.3. Required Abatement Notification Items:

(1) Name, address, telephone number and license number of the asbestos Contractor.
(2) Provide the name (i.e., facility number), address, location, size, and age of each facility at which asbestos abatement activities will be carried out.
(3) The anticipated dates during which asbestos abatement activities shall occur.
(4) Provide separate estimates of the amount of friable and non-friable asbestos containing materials present in each facility in terms of linear feet of pipe and square feet of surface area or other facility components.
(5) For each facility, provide drawings showing location of the asbestos-containing material being removed.
(6) A statement of asbestos abatement cost or gross contract price.
(7) Scheduled starting and completion date(s) of demolition or renovation. Note: If it is determined that actual start time stated on notification form is not met, then within 24 hours of the start date designated, the Contractor shall notify the Texas Department of Health of a new start date. This shall be accomplished through an amended notification form. Contractor shall complete as soon as possible. Contractor shall be responsible for mailing amended form to the appropriate agencies to ensure timely arrival.
(8) Project work hours.
(9) A general description of the work practices that will be followed, including area containment and worker protection measures that are proposed.
(10) A description of the method(s) of asbestos abatement.
(11) A list of employees who will be involved in the activity, giving the registration number of each employee and license number of each supervisor.
(12) A statement of the disposal methods for the waste asbestos-containing materials. This will include the name and location of the state approved disposal site.

9.4.3.4. The Contractor shall install warning signs demarcating the work or regulated area, if or when the airborne concentration of asbestos may be expected to exceed the permissible exposure limit. The warning signs shall be in conformance with and placed in accordance with 29 CFR 1926.1101.

9.4.4. Fees

9.4.4.1. The Contractor shall pay all required fees associated with the asbestos abatement activities. Fees to be paid by the Contractor shall include, but not be limited to, notification submittal fees, landfill disposal fees, and any associated licensing, registration, or training fees.

9.4.4.2. In accordance with 25 TAC 295.61(j), payment of an asbestos notification fee, based on the amount of asbestos removed, will be required by the TDH. Subsequent to submittal of the asbestos notification as described above, an invoice for the fee will be sent by the TDH to the Government for payment. Upon receipt, the invoice will be forwarded to the Contractor for payment. Payment of the invoice must be remitted by the Contractor in the manner instructed on the invoice.

9.4.4.3. The payment of fees by the Contractor shall be submitted to the appropriate entity within the required established timeframe. Payment of fines and/or penalties resulting from failure to submit a fee payment in a timely fashion is also the responsibility of the Contractor.

9.4.4.4. Contractor shall submit proof of fee payment, including the date payment was made, within ten (10) days of invoice payment. Proof of payment shall be submitted to 7 CES/CEIE.

9.5. MATERIALS AND EQUIPMENT:

9.5.1. Materials:

9.5.1.1. All asbestos abatement materials, specified by EPA and OSHA laws and regulations, shall be provided by the Contractor.

9.5.1.2. Deliver all materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.

9.5.1.3. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under sufficient cover to prevent damage or contamination.

9.5.1.4. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated with asbestos shall be either cleaned or disposed of as asbestos-containing waste material in accordance with applicable regulations. Waste materials generated during cleaning must be handled and disposed of as asbestos-containing waste material.

9.5.2. Tools and Equipment: Contractor shall provide all tools and equipment as specified in the EPA and OSHA laws and regulations governing the abatement of asbestos containing material

9.6. BUILDING AND FIXTURE PROTECTION:

9.6.1. The Contractor shall take all necessary actions and precautions to protect the building and fixtures from damage during execution of all associated work. If the building or any portion thereof is damaged due to the Contractor's operations or negligence, the Contractor shall replace or repair such, to its condition prior to the commencement of the project, at no additional cost to the Government. Asbestos contamination of any areas of the building in which the abatement is being performed will be construed as damage.

9.6.2. If shutdown of electric power to the working area becomes necessary, temporary power, as available, may be obtained from other parts of the building. All power connections shall be in accordance with National Electrical Code 2000. In the event outside or portable electrical power is required, the Contractor shall make provisions for such at no additional cost to the Government. The Contractor must notify the CO prior to utilization of any alternate power supply.

9.7. WORK PRACTICES: Execution shall be in accordance with work practices established by the most stringent federal, regional, state, and local regulatory agencies.

9.7.1. At work sites where the presence of airborne asbestos concentration are lower than (and can reasonably be expected not to exceed) the action level, the Contractor's asbestos removal practices, as a

minimum, shall comply with the provision of 40 CFR 61 (amended) Subpart M. If initial air monitoring determines the airborne concentrations of asbestos exceed (or can reasonably be expected to exceed) the action level, the Contractor's asbestos removal practices shall comply as a minimum with the requirements of 29 CFR 1910.1001, 29 CFR 1926.103, and 40 CFR 61 Subpart M, 40 CFR 763, and 25 TAC 295.

9.7.2. The work practices and procedures for providing employees protection, as stipulated in 29 CFR 1926.103 and required by paragraph 9.7.1, shall be provided by the Contractor. The Contractor shall be required under this contract to comply with all 29 CFR 1926.103 Appendices, mandatory and non-mandatory.

9.7.3. Final Cleanup and Clearance: The Contractor shall perform a minimum of two wet cleaning operations of the regulated work areas. The Contractor shall notify the inspector within 24 hours that the regulated area is ready for visual inspection. If this inspection reveals any dust settlement, the regulated areas shall be cleaned again, using wet methods and/or HEPA vacuum equipment. When the regulated area is found free of any visible dust by the CO's representative, the abated surfaces may be treated with a sealant prior to collection of clearance air samples.

9.7.3.1. The collection and analysis of air samples shall be in accordance with 40 CFR 763. All clearance air samples collections shall be coordinated at least 24 hours prior to collection with the CO. The Government may take air samples for separate evaluations.

9.7.3.2. The maximum concentration of airborne asbestos fibers or cleanliness for clearance air samples shall be 0.01 fibers per cubic centimeter. The Contractor shall repeat cleaning of regulated areas as many times as is necessary to attain this required level at no additional cost to the Government. Clearance for air samples shall be by "PCM" unless the Contractor chooses to use "TEM." Split samples shall be provided to the Government for independent analysis for initial and clearance samples.

9.7.3.3. Final clearance shall be granted only after the completion of final cleaning and approval of clearance air sample analysis stipulated in paragraphs 9.7.3, 9.7.3.1, and 9.7.3.2.

9.7.3.4. The demolition of the regulated work area shall only be accomplished upon approval of the CO.

9.7.4. Shipments of asbestos-containing waste materials shall be made only after the completion of a manifest signed by the Dyess AFB Civil Engineer Squadron Environmental Section representative. Preparation of manifest will only be between 0730 and 1600 Monday thru Friday. The Contractor shall ensure a fully executed copy of each manifest is provided the CO within two weeks after each shipment.

9.7.5. Transportation of RACM and asbestos-containing waste materials shall be in accordance with 40 CFR 61 Subpart M, 49 CFR 172, and state regulations.

9.7.6 The disposal of RACM shall be at the BFI Regional Landfill, north of Abilene, Texas.

9.7.7. The Contractor is responsible for demarcating the work or regulated area, if the air borne concentration of asbestos fibers is expected to exceed 0.1 fibers per cubic centimeter.

10. UNDERGROUND STORAGE TANK (UST) REMOVALS: When a project involves UST removals, the Contractor shall possess an approved TCEQ license. Additionally, a written NOI shall be received by the TCEQ at least thirty (30) calendar days prior to Contractor's proposed UST pull date. This NOI is to allow TCEQ personnel to visit the project and review the actual UST pull and to review the condition of the soil/water surrounding the UST. Additionally, the NOI shall be signed by 7 CES/CEIE. Contractor shall submit this NOI and a copy of their TCEQ approved license to 7 CES/CEIE for signature prior to mailing to the TCEQ. A copy of the signed NOI shall be provided to the CO. UST removals shall be completed IAW 30 TAC 334.

11. RELEASE OF FLUIDS TO THE SANITARY SEWER SYSTEM: DAFB's sanitary sewer system discharges into the Publicly Owned Treatment Works (POTW) operated by the City of Abilene, Texas. This POTW has established testing requirements for certain constituents as well as discharge limits of those same constituents. Accordingly, any Contractor performing work at DAFB and

contemplating a release of non-hazardous water into the sanitary sewer system shall comply with the testing/release requirements established by the City of Abilene. Contractor is also responsible for any and all testing, monitoring, measuring, documenting, etc. to prove compliance with same. These POTW testing/discharge criteria is included at the end of this section.

12. REMOVAL OF MONITOR WELLS: When required by the project, monitor wells shall be removed and plugged pursuant to Chapter 32.017 of the Texas Water Code and IAW 30 TAC 338, Water Well Drillers General Provisions. The removal of concrete pad and plugging at these well locations shall be accomplished IAW 30 TAC 338.2, 338.41, 338.42, 338.43, 338.44, 338.45, 338.46, 338.47, 338.48, 338.49, 338.50, 338.71, 338.73, and 338.91.

12.1. All removable casing shall be removed from the well. If removal is unsuccessful, casing shall be removed to a minimum depth of one foot (12") below finished grade. The well base shall be completely filled with cement (1 part Portland to 1 part water) from the bottom up. The concrete pads at the well sites must be completely demolished to a depth of one foot (12") minimum. All debris generated by this contract shall become the property of the Contractor and be removed from the well site and disposed of properly. After concrete pads are removed, the excavation area shall then be backfilled, compacted, and finished to match the surrounding area.

All well work shall be accomplished by a water well driller with a current license issued by the State of Texas pursuant to the provisions of the Water Well Drillers Act (WWDA), Texas Civil Statutes, Article 7621e(338.2). All applicable rules and regulations established by the TCEQ shall be strictly followed during work under this contract at DAFB. All forms, logs, and reports required under this contract which are due to the TCEQ shall be completed and submitted by the Contractor. A copy of all submitted forms, logs, and reports shall be forwarded to 7 CES/CEIE, 710 Third Street, DAFB, TX 79605-1670. Required forms shall include Form No. WWD-009 (Rev. 07/27/88), State of Texas Plugging Report. All completed report forms shall be submitted to the CO for approval within fifteen (15) calendar days of completion of each well plugging activity.

13. INSTALLATION OF BACKFLOW PREVENTORS: All fire hydrants on base must be used in conjunction with an approved Class III Back Flow Preventer (reduced pressure principle device) and screw type globe valve attached to the hydrant. Refer to "Contractor Request for Use of Dyess AFB Fire Hydrants" in Section 00 01 03 – Utilities for additional requirements.

14. REMOVAL/RECOVERY OF REFRIGERANTS: All refrigerants removed under this contract shall remain the property of the Government, be placed in cylinders approved for the storage of such refrigerants, and be recovered by operators trained to accomplish such tasks IAW 40 CFR 82. Trained operators shall retain proof of refrigerant recovery certification at all times while performing recovery refrigerant operations. The cylinders shall be properly labeled as to its contents and the date of recovery as well as being marked with a 6" wide yellow band applied around the entire circumference, measured from the valve down the side of the cylinder. The yellow band will distinguish recovered refrigerant from virgin refrigerant.

CITY OF ABILENE, TEXAS (POTW) TESTING/DISCHARGE CRITERIA

All discharges of non-hazardous water to the sanitary sewer system at DAFB shall be tested for the following constituents and shall comply with the listed discharge limits:

Constituent	**Limit**
Arsenic	0.80 mg/l
Barium	10.0 mg/l
Beryllium	1.0 mg/l
Cadmium	0.50 mg/l
Chromium	3.00 mg/l
Copper	1.10 mg/l
Cyanide	0.50 mg/l
Lead	1.00 mg/l
Manganese	8.00 mg/l
Mercury	0.02 mg/l
Nickel	3.00 mg/l
Selenium	0.70 mg/l
Silver	0.20 mg/l
Zinc	1.80 mg/l
Benzene	0.040 mg/l
Toluene	14.3 mg/l
Ethyl Benzene	1.4 mg/l
Xylene	10.0 mg/l
Total Petroleum Hydrocarbons	20.0 mg/l or 167 lbs/day
Biochemical Oxygen Demand	2000 lbs/day
Total Suspended Solids	2500 lbs/day
pH	5.5 - 11.0
Fats, Oils, and Greases	834 lbs/day

These constituents shall be analyzed IAW the methods set forth in 40 CFR 136 which designates an EPA method number or a method described in the 17th Edition of Standard Methods For the Examination of Water and Wastewater.

As an example and for clarification, non-hazardous water could be placed into a 1500 gallon capacity tank. If a single, representative sample is extracted and analyzed for the above set of constituents and the results were below the limits annotated above, the entire contents of the tank could be discharged into the sanitary sewer system upon approval from the POTW.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

TR-06-X (2006; Supplement 2009) A/E/C (Architectural, Engineering, and Construction) CADD Standard - Release 3.0

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-300-08 (2009, with Change 1) Criteria for Transfer and Acceptance of DoD Real Property

1.3 PROJECT RECORD DOCUMENTS

1.3.1 Record Drawings

Drawings showing final as-built conditions of the project. This paragraph covers record drawings complete, as a requirement of the contract. The terms "drawings," "contract drawings," "drawing files," "working record drawings" and "final record drawings" refer to contract drawings which are revised to be used for final record drawings showing as-built conditions. The final CADD record drawings must consist of one set of electronic CADD drawings & PDF files in the specified format, one set of bond drawings, and one set of the approved working Record drawings.

1.3.1.1 Government Furnished Materials

All available and relevant as-built drawings are provided by the Government as electronic copy on CD-Rom in either *.tif images or *.dwg Autocad drawing formats. All existing site, utility, facility conditions and dimensions shall be field verified by Contractor or Architect/Engineer.

1.3.1.2 Working Record and Final Record Drawings

Revise 2 sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. Keep these working as-built marked drawings current on a weekly basis and at least one set available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction must be accurately and neatly recorded as they occur by means of details and notes. Prepare final record (as-built) drawings after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). The working as-built marked prints and final record (as-built) drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer and the Contractor prior to submission of each monthly pay estimate. If the Contractor fails to maintain the working and final record drawings as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the record drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of updated drawings. Show on the working and final record drawings, but not limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators

become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.

b. The location and dimensions of any changes within the building structure.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

d. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.

e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

f. Changes or modifications which result from the final inspection.

g. Where contract drawings or specifications present options, show only the option selected for construction on the final as-built prints.

h. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, furnish a contour map of the final borrow pit/spoil area elevations.

i. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.

1.3.1.4 Computer Aided Design and Drafting (CADD) Drawings

Only employ personnel proficient in the preparation of CADD drawings to modify the contract drawings or prepare additional new drawings. Additions and corrections to the contract drawings must be equal in quality and detail to that of the originals. Accomplish additions and corrections to the contract drawings using CADD files. Provide all program files and hardware necessary to prepare final record drawings. The Contracting Officer will review final record drawings for accuracy and return them to the Contractor for required corrections, changes, additions, and deletions. Provide linetype & color schedule indicating line thickness and color for all items used in the drawings for each discipline on the final submittal CD.

a. Provide CADD drawings all drawn full scale in model space. Provide mview windows in paperspace with appropriate scale for each detail. Provide graphic scale for each detail or plan per page. All drawings shall be placed on Government provided 22x34 titleblock. All text height shall be 3/32 inch minimum when plotted full size. Refrain from using fonts that create “tails” or other extensions. Use fonts similar to RomanS or other easily legible fonts due to the majority of prints being reproduced at half size.

b. Name the Contract Drawing files prior to submittal to Government in a manner related to the FNWZ contract number (i.e., 08-0083 - 02 of 52 - A01.dwg) or as instructed in the Pre-Construction conference. The prefix shall be the project number separated by a dash followed by

the sequence numbers followed by the project sheet number suffix. This file naming maintains the sheet sequence in the project directory. Ensure all drawing references are bound or updated.

c. When final revisions have been completed, show the wording "RECORD DRAWINGS / AS-BUILT CONDITIONS" followed by the name of the Contractor in letters at least 3/16 inch high on the cover sheet drawing. Mark all other contract drawings either "Record" drawing denoting no revisions on the sheet or "Revised Record" denoting one or more revisions. Date original contract drawings in the revision block.

d. Within 10 days of substantial completion of all phases of work, submit the final record drawing package for the entire project in PDF form and one (~~22x34~~ 11x17) bound set to Government for approval. Upon approval, submit one revised set of electronic files (dwgs & pdf's) on compact disc, read-only memory (CD-ROM), and one loose sheet drawing set of 22lb paper bond prints. The Government reserves the right to reject any drawing files it deems incompatible with the customer's CADD system. Paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final record drawing files and marked prints as specified will be cause for withholding any payment due the Contractor under this contract. Approval and acceptance of final record drawings must be accomplished before final payment is made to the Contractor.

1.3.1.5 Payment

No separate payment will be made for record drawings required under this contract, and all costs accrued in connection with such drawings are considered a subsidiary obligation of the Contractor.

1.3.3 Final Approved Shop Drawings

Furnish final approved project shop drawings 30 days after transfer of the completed facility.

1.3.4 Construction Contract Specifications

Furnish final record (as-built) construction contract specifications, including modifications thereto, 30 days after transfer of the completed facility.

1.3.5 The Contractor is required, prior to the final inspection to submit a listing of all equipment or material carrying a Manufacturer's warranty or as indicated in the specifications. Use the following summary for each item and attach manufacturer's certificate as appropriate.

Equipment
Warranty / Guarantee Record
Facility No: _ Project No: FNWZ _____
Project Title: _____ Work Order: _____ Shop Code: __
Item: _ Location: _ Contractor: _____
Prefix: _____ Suffix: ___ Serial No: _____ Model No: ___
Style: _ HZ: _ Volts: ____ HP: _ Size: _____ Frame: _____
Purchase Cost: ___ Replacement Cost: _____ Manufacturer: _
Date Purchased: __ Date Installed: _____
Effective Date: ___ Expiration Date: _____
Replacement, New or Other: __ Purchase Number: __
GSA Contract Number: _
Contract Inspector: _____ Phone: _____

Remarks: ___
Evaluator: __ Grade: ___ Title: _____ Orgn: _

1.3.6 CONSTRUCTION DATA WORKSHEET: The Contractor shall to submit a completed copy of the Construction Data Worksheet found at the end of this document at the following times:

a. With the First Progress Schedule
b. Prior to the final inspection. This will include any modifications to the contract.

This worksheet is used by the Air Force to inventory and capitalize new work. The Contractor shall complete only those areas of the form that are applicable to the work included in this project. Additional category codes may be identified by the Government for inclusion in the worksheet. Contractor shall also identify demolition quantities of items removed during the contract. The Contractor has the option of using the AF 1354 form.

CONSTRUCTION DATA WORKSHEET

I. DESCRIPTION OF PROJECT: _____
PROJECT NO: FNWZ _____ WORK ORDER NO:_____
CONTRACT NO: _____
FACILITY NO:_____ COMPLETION DATE:_____

II. GENERAL DATA (for construction to existing facilities, only provide data for the new addition):

Main Building _____
Wings _____
Offsets _____
Total SF _____

Number of Floors: _____

Construction Material:

Foundation _____ (concrete slab on grade, piers, etc)
Floors _____ (carpet, tile, sealed concrete)
Walls _____ (metal stud, CMU, wood stud, brick veneer)
Roof Structure _____ (wood, steel joists, etc.)
Roof Finish _____ (BUR, shingles, metal roof)
Roof Pitch _____

III. Utilities / Related Facilities – Addition / (Deletion):

Cat Code	Nomenclature	U / M	Amount	Cost
132-133	Pad, Equipment	SY		
812-223	Prim Distr. Lne OH	LF		
812-224	Sec / Distr. Lne OH	LF		
812-225	Prim Distr. Lne UG	LF		
812-226	Secdary Distr. Lne UG	LF		
812-926	Ext. Area Lighting	EA		
	(Street / Parking lights -	No. of Poles)		
813-301	Transformer Station	EA		
		KV		
824-464	Gas Mains	LF		
831-169	Sewage Septic Tank	KG		
832-266	Sanitary Sewer Main	LF		
842-245	Water Distr. Mains	LF		

843-315	Fire Hydrants	EA
851-143	Curbs & Gutters	LF
851-145	Driveway	SY
851-147	Road	SY
852-261	Veh Parking (Ops)	SY
852-262	Veh Parking (Non Org)	SY
871-183	Storm Drain	LF
872-247	Security Fence	LF

IV. Systems - Addition / (Deletion):

A. FIRE PROTECTION:

Cat Code	Nomenclature	U / M	Amount	Cost
872-248	Interior Fence	LF		
852-289	Sidewalk	SY		
890-187	Utility Vault (4 or more transformers)	SF		
135-583	Telephone Duct Fac	LF		
135-586	Telephone Pole Fac	EA		
880-211	Closed Head Auto Sprinklers	SF #Heads		
880-212	Open Head Deluge System	SF #Heads		
880-221	Auto Fire Detection System	SF #Heads		
880-222	Int Manual FR Alarm	EA #Devices		
880-231	C02 Fire System	EA		
880-232	Foam Fire System	EA		
880-233	Other Fire System	EA		
843-315	Fire Hydrant	EA		
890-272	EMCS Field Equip	EA		

B. SECURITY SYSTEMS:

872-841	Security Alarm Sys	EA

V. PLANTS:

890-126	A/C Window Units	TN SF
890-125	A/C Plt Less Than 5 TN	TN SF
890-121	A/C Plt 5 to 25 TN	TN
826-122	A/C Plt 25 to 100 TN	TN
826-123	A/C Plt Over 100 TN	TN
821-115	Htg Plt 750 / 3500 MB	MB
821-116	Htg Plt over 3500 MB	MB
811-147	Electric Emergency	KW

VI. ANY ADDITIONAL COMMENTS OR REMARKS:

TOTAL COST OF PROJECT $ _____

I certify that the information provided is complete and accurate to the best of my knowledge.

_____	_____
CONTRACTOR	CONTRACTING REPRESENTATIVE
_____	_____
DATE	DATE

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

**** END OF SECTION ****

PART 1 - GENERAL

1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal.

Contractor shall submit **TWO** complete sets of O&M Data.

1.1.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted. Document shall be submitted in a three ring binder with index and labeled tabs to separate the sections required herein. Binder shall be labeled with the complete Project Number, Project Title, Project Location, Contractor's Name, Address, and Contact Information on the outside cover & spine. Binders shall be white with clear inserts.

1.1.2 Package Content

Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.

1.1.3 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, shall be submitted by the Contractor within 30 calendar days of the notification of this change requirement.

1.1.4 Electronic Submittal

Contractor shall submit the entire final O&M Data set in PDF form. All cut sheets & product information shall be generated from original electronic data; no scans are allowed due to file size.

1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.3.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.3.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

1.3.1.2 Operator Prestart

Include procedures required to install, set up, and prepare each system for use.

1.3.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.3.1.4 Normal Operations

Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.

1.3.1.5 Emergency Operations

Include Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of all utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.3.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gage readings.

1.3.1.7 Environmental Conditions

Include a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item equipment should not be allowed to run.

1.3.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.3.2.1 Lubrication Data

Include preventative maintenance lubrication data, in addition to instructions for lubrication provided under paragraph titled "Operator Service Requirements":

a. A table showing recommended lubricants for specific temperature ranges and applications.

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

c. A Lubrication Schedule showing service interval frequency.

1.3.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

1.3.2.3 Cleaning Recommendations

Provide environmentally preferable cleaning recommendations in accordance with ASTM E 1971.

1.3.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.3.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.3.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.3.3.3 Maintenance and Repair Procedures

Include instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.3.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

1.3.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.3.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including requirements by type of craft. Corrective maintenance that requires completion or participation of the equipment manufacturer shall be identified and tabulated separately.

1.3.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

1.3.5.1 Product Submittal Data

Provide a copy of all Product Data submittals required in the applicable technical sections.

1.3.5.2 Manufacturer's Instructions

Provide a copy of all Manufacturer's Instructions submittals required in the applicable technical sections.

1.3.5.3 O&M Submittal Data

Provide a copy of all Operation and Maintenance Data submittals required in the applicable technical sections.

1.3.5.4 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and

source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog

1.3.5.5 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

1.3.5.6 Personnel Training Requirements

Provide information available from the manufacturer that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.3.5.7 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.3.5.8 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms.

1.3.5.9 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.4 TYPES OF INFORMATION REQUIRED IN CONTROLS O&M DATA PACKAGES

Include Data Package 5 and the following for control systems:

a. Narrative description on how to perform and apply all functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.

b. Full as-built sequence of operations.

c. Copies of all checkout tests and calibrations performed by the Contractor (not Cx tests).

1.5 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

1.5.5 Data Package 5

a. Safety precautions

b. Operator prestart

c. Start-up, shutdown, and post-shutdown procedures

d. Normal operations

e. Environmental conditions

f. Preventive maintenance plan and schedule

g. Troubleshooting guides and diagnostic techniques

h. Wiring and control diagrams

i. Maintenance and repair procedures

j. Removal and replacement instructions

k. Spare parts and supply list

l. Product submittal data

m. Manufacturer's instructions

n. O&M submittal data

o. Parts identification

p. Testing equipment and special tool information

q. Warranty information

r. Testing and performance data

s. Contractor information

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI Guideline K (Current revision) Containers for Recovered Fluorocarbon Refrigerants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.6 (Current revision) Safety Requirements for Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1(2003) Safety -- Safety and Health Requirements

U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA 4145.25(Current Revision) Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61-SUBPARTS M National Emission Standard for Asbestos

40 CFR 82 Protection of Stratospheric Ozone

1.2 GENERAL REQUIREMENTS

Do not begin demolition until authorization is received from the Contracting Officer. The work includes complete facility demolition. All structure, foundations/footings, building slabs and building appurtenances within the facility footprint and 5 ft. beyond shall be demolished and removed as described in the Task Order (TO). The work also includes demolition, salvage of items and materials identified in the TO, and removal of resulting rubbish and debris. Rubbish and debris shall be removed from Government property daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer. In the interest of occupational safety and health, the work shall be performed in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections. In the interest of conservation, salvage shall be pursued to the maximum extent possible in accordance with Section, 00 01 04 Environmental, if applicable; salvaged items and materials shall be disposed of as specified.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G"

designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 00 01 02 Special Conditions, paragraph "Submittals:".

Demolition plan; G

Notifications

Notification of Demolition and Renovation forms; G
Submit proposed salvage, demolition and removal procedures to the Contracting Officer for approval before work is started.

1.4 REGULATORY AND SAFETY REQUIREMENTS

Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," safety requirements shall conform to ANSI A10.6 and EM 385-1-1.

1.4.1 Notifications

1.4.1.1 General Requirements

Furnish timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61-SUBPART M. Notify the State's environmental protection agency and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61-SUBPART M.

1.5 DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

1.6 PROTECTION

1.6.1 Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Contracting Officer prior to beginning such work. Refer to Section 00 01 02 General; "Street Closings:".

1.6.2 Existing Work

For each individual TO and before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work

performed under this contract. Do not overload structural elements and pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition or removal work. Repairs, reinforcement, or structural replacement must have Contracting Officer approval.

1.6.3 Weather Protection

For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent displacement.

1.6.4 Trees

Trees within the project site, which might be damaged during demolition, and which are indicated to be left in place, shall be protected by a 6 foot high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the Contracting Officer.

1.6.5 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, shall remain standing without additional bracing, shoring, of lateral support until demolished, unless directed otherwise by the Contracting Officer. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.6.6 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.7 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.8 FOREIGN OBJECT DAMAGE (FOD)

Aircraft and aircraft engines are subject to FOD from debris and waste material lying on airfield pavements. Remove all such materials that may appear on operational aircraft pavements due to the Contractor's operations. If necessary, the Contracting Officer may require the Contractor to install a temporary barricade at the Contractor's expense to control the spread of FOD potential debris. The barricade shall consist of a fence covered with a fabric designed to stop the spread of debris; anchor the fence and fabric to prevent displacement by winds or jet/prop blasts. Remove barricade when no longer

required.

1.9 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated in the individual TO with workmen skilled in the trades involved. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by the Contracting Officer.

1.10 REQUIRED DATA

Demolition plan shall include procedures for coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Include statements affirming Contractor inspection of the existing roof deck and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work. The procedures shall provide for safe conduct of the work in accordance with EM 385-1-1.

1.11 ENVIRONMENTAL PROTECTION

The work shall comply with the requirements of Section 00 01 04 Environmental.

1.12 USE OF EXPLOSIVES

Use of explosives will not be permitted.

1.13 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available in accordance with the following schedule:

Area	Date
PER TASK ORDER	PER TASK ORDER

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

The Contractor shall prevent movement or settlement of adjacent structures not included in the demolition work. Bracing and shoring shall be provided as necessary. Cease operations and notify the Contracting Officer immediately if adjacent structures, not included in the demolition work, appear to be endangered. Do not resume operations until approved by the Contracting Officer. The Contractor shall protect existing landscaping materials, utilities, appurtenances structures that are not to be demolished.

3.1 EXISTING FACILITIES TO BE REMOVED

3.1.1 Structures

Existing structures indicated in the individual TO shall be removed to 3 feet below grade. Interior walls,

other than retaining walls and partitions, shall be removed to 3 feet below grade or to top of concrete slab on ground. Basement slabs shall be broken up to permit drainage. Sidewalks, curbs, gutters and street light bases shall be removed as indicated in the individual TO. For existing drilled piers remove drilled piers 3 feet below grade.

3.1.2 Utilities and Related Equipment

Remove existing utilities, as indicated in the individual TO and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area. Refer to Section 00 01 03 Utilities.

3.1.3 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs as indicated in the individual TO to a depth of 12 inches below new finish grade. Provide neat saw cuts at limits of pavement removal as indicated in the individual TO.

3.1.5 Masonry

Saw cut and remove masonry so as to prevent damage to surfaces to remain. Where new masonry adjoins existing, the new work shall abut or tie into the existing construction as indicated in the individual TO.

3.1.6 Concrete

Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete.

3.1.8 Patching

Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Finished surfaces of patched area shall be flush with the adjacent existing surface and shall match the existing adjacent surface as closely as possible as to texture and finish. Patching shall be as specified and indicated, and shall include:

a. Holes and depressions caused by previous physical damage or left as a result of removals in existing masonry walls to remain shall be completely filled with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.

b. Where existing partitions have been removed leaving damaged or missing resilient tile flooring, patch to match the existing floor tile.

c. Patch acoustic lay-in ceiling where partitions have been removed. The transition between the different ceiling heights shall be effected by continuing the higher ceiling level over to the first runner on the lower ceiling and closing the vertical opening with a painted sheet metal strip.

3.1.9 Air Conditioning Equipment

Recover all refrigerants prior to removing air conditioning equipment in accordance with Section 00 01 04 Environmental.

3.1.10 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

3.1.11 Locksets on Swinging Doors

The Contractor shall remove all locksets from all swinging doors indicated to be removed and disposed of. Contractor shall give the locksets to the Contracting Officer after their removal.

3.2 FILLING

Holes, open basements and other hazardous openings shall be filled in accordance with UFGS Section 31 23 00.00 20 “Excavation and Fill”.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except where specified in other sections and in the individual TO, all materials and equipment removed, and not reused, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition and removal procedures, and authorization by the Contracting Officer to begin demolition. The Government will not be responsible for the condition or loss of, or damage to, such property after TO is awarded. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

3.3.2 Reuse of Materials and Equipment

Remove and store materials and equipment listed in the TO to be reused or relocated to prevent damage, and reinstall as the work progresses.

3.3.3 Salvaged Materials and Equipment
Remove materials and equipment that are indicated in the TO and specified to be removed by the Contractor and that are to remain the property of the Government, and deliver to a storage site, approved by the Contracting Officer.

Contractor shall salvage items and material to the maximum extent possible.

Material salvaged for the Contractor shall be stored as approved by the Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

Salvaged items indicated in the TO to remain the property of the Government shall be removed in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items. Containers shall be properly identified as to contents.

The items indicated in the individual TO to be reserved as property of the using service shall be removed prior to commencement of work. Contractor shall coordinate with the Contracting Officer and the using service at least 30 days prior to commencement of work to allow the removal of such items.

Remove and capture all Class I ODS refrigerants in accordance with section 01 57 20 "Environmental Protection".

3.3.4 Disposal of Ozone Depleting Substance (ODS)

Refer to Section 00 01 04 Environmental.

3.3.4.1 Fire Suppression Containers

Fire suppression system cylinders and canisters with electrical charges or initiators shall be deactivated prior to shipment. Also, safety caps shall be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.3.5 Unsalvageable Material

Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of per Section 00 01 02 Special Conditions, "DISPOSITION OF WASTE, EXCESS, SCRAP, AND SALVAGE MATERIALS" and Section 00 01 04 Environmental.

3.4 CLEANUP

Debris and rubbish shall be removed from the entire work area, and adjacent areas affected by the work. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

**** END OF SECTION ****

PART 1 GENERAL

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 111	(2011; R 2015) Standard Method of Test for Mineral Matter or Ash in Asphalt Materials

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A1011/A1011M	(2015) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
ASTM A109/A109M	(2014) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A480/A480M	(2016) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM B152/B152M	(2013) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C919	(2012) Use of Sealants in Acoustical Applications
ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM D1751	(2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for

	Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2013) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D2628	(1991; R 2011) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2012) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D4	(1986; R 2010) Bitumen Content
ASTM D412	(2015a) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D5249	(2010; R 2016) Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D6/D6M	(1995; E 2011; R 2011) Loss on Heating of Oil and Asphaltic Compounds

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

SD-03 Product Data

Preformed Expansion Joint Filler
Sealant

SD-04 Samples

Lubricant for Preformed Compression Seals
Field-Molded Type

SD-07 Certificates

Preformed Expansion Joint Filler
Sealant

1.4 DELIVERY, STORAGE, AND HANDLING

Protect material delivered and placed in storage off the ground from moisture, dirt, and other contaminants. Deliver sealants in the manufacturer's original unopened containers. Remove sealants from the site whose shelf life has expired.

PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Use 3 mm (1/8 inch) thick tempered hardboard contraction joint strips conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips must have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Use preformed expansion joint filler material conforming to ASTM D1751 or ASTM D1752, Type I, or resin impregnated fiberboard conforming to the physical requirements of ASTM D1752. Submit certified manufacturer's test reports for premolded expansion joint filler strips, compression seals and lubricant, and metallic waterstops to verify compliance with applicable specification. Unless otherwise indicated, filler material must be 10 mm (3/8 inch) thick and of a width applicable for the joint formed. Backer material, when required, must conform to ASTM D5249.

2.3 SEALANT

Joint sealant conforming to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.3.2 Lubricant for Preformed Compression Seals

ASTM D2835. Submit a piece not less than 3 m (9 ft) of 25 mm (1 inch) nominal width or wider seal or a piece not less than 4 m (12 ft) of compression seal less than 25 mm (1 inch) nominal width. Provide one L (quart) of lubricant.

2.3.3 Field-Molded Type

ASTM C920. Use Type M, Grade P or NS, Class 25, Use [T] [NT] sealant for horizontal joints. Type M, Grade NS, Class 25, Use NT for vertical joints.[Except, the joint sealant that will be submerged underwater for part or all of its service life must meet the requirements of USE I.] Use polyethylene tape, coated paper, metal foil or similar type materials as bond breaker. The back-up material must be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber. Submit 4 L (1 gallon) of field-molded sealant and 1 L (quart) of primer (when primer is recommended by the sealant manufacturer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

PART 3 EXECUTION

3.1 INSTALLATION

Provide joint locations and details, including materials and methods of installation of joint fillers, as specified and indicated. In no case may any fixed metal be continuous through an expansion or contraction joint.

3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Make joints 3 mm to 5 mm (1/8 inch to 3/16 inch) wide and extend into the slab one-fourth the slab thickness, minimum, but not less than 25 mm (1 inch).

3.1.1.1 Joint Strips

Provide strips of the required dimensions and as long as practicable. After the first floating, groove the concrete with a tool at the joint locations. Insert the strips in the groove and depress them until the top edge of the vertical surface is flush with the surface of the slab. Float and finish the slab as specified. Work the concrete adjacent to the joint the minimum necessary to fill voids and consolidate the concrete. Where indicated, saw out the top portion of the strip after the curing period to form a recess for sealer. Discard the removable section of PVC or HIPS strips and leave the insert in place. Maintain true alignment of the strips during insertion.

3.1.1.2 Sawed Joints

Saw joints early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Start cutting as soon as the concrete has hardened sufficiently to prevent raveling of the edges of the saw cut. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use concrete sawing machines that are adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Cut joints to true alignment and in sequence of concrete placement. Remove sludge and cutting debris. Form reservoir for joint sealant.

3.1.1.3 Bond Breaker

Coat joints requiring a bond breaker with curing compound or with bituminous paint.

3.1.2 Expansion Joints

Use preformed expansion joint filler in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. Extend the filler to the full slab depth, unless otherwise indicated. neatly finish the edges of the joint with an edging tool of 3 mm (1/8 inch) radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, install the filler strips at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. Remove the wood strip after the concrete has set.

Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. Thoroughly clean the groove of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust. If blowing out the groove use oil-free compressed air.

3.1.3 Joint Sealant

Fill sawed contraction joints and expansion joints in slabs with joint sealant, unless otherwise shown. Joint surfaces must be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Apply joint sealant as recommended by the manufacturer of the sealant.

3.1.3.1 Joints With Preformed Compression Seals

Install compression seals with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5 percent stretching of the seal. Cover the sides of the joint and, if necessary, the sides of the compression seal with a coating of lubricant. Coat butt joints with liberal applications of lubricant.

3.1.3.2 Joints With Field-Molded Sealant

Do not seal joints when the sealant material, ambient air, or concrete temperature is less than 4 degrees C (40 degrees F). When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors follow the guidance provided in ASTM C919. Coat joints requiring a bond breaker with curing compound or with bituminous paint. Install bond breaker and back-up material where required. Prime joints and fill flush with joint sealant in accordance with the manufacturer's recommendations.

3.3 CONSTRUCTION JOINTS

Treat construction joints coinciding with expansion and contraction joints as expansion or contraction joints as applicable.

-- End of Section --

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ACI INTERNATIONAL (ACI)

a.	ACI 301	Specifications for Structural Concrete
b.	ACI 318/318R	Building Code Requirements for Structural Concrete and Commentary
c.	ACI SP-66	ACI Detailing Manual

1.1.1.2 AMERICAN WELDING SOCIETY (AWS)

a.	AWS D1.4	Structural Welding Code - Reinforcing Steel

1.1.1.3 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
b.	ASTM A 184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
c.	ASTM A 185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
d.	ASTM A 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
e.	ASTM A 497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
f.	ASTM A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
g.	ASTM A 706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
h.	ASTM A 767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
i.	ASTM A 775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
j.	ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
k.	ASTM A 884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement

l. ASTM C 1116 Standard Specification for Fiber-Reinforced Concrete and Shotcrete

m. ASTM E 94 Standard Guide for Radiographic Examination

1.1.1.4 CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

a. CRSI 1MSP Manual of Standard Practice

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Reinforcement

(1) The Contractor shall submit shop drawings which include: reinforcement steel placement drawings; reinforcement steel schedules showing quantity, size, shape, dimensions, weight per foot, total weights and bending details; and details of bar supports showing types, sizes, spacing and sequence.

1.2.1.2 SD-03 Product Data

a. Welding

(1) A list of qualified welders names with copies of welding certificates.

b. Butt-Splice Welding

(1) Submit proposed procedure for butt-splicing steel bars prior to making the test butt-splices for qualification of the procedure. Properties and analyses of steel bars and splicing materials shall be included in the submitted procedure. Physical properties of splicing sleeves shall include length, inside and outside diameters, and inside surface details.

1.2.1.3 Samples

a. Epoxy-Coated Bars

(1) Sample of coating material and 1.5 pounds of patching material shall be submitted with the delivery of the bars.

1.2.1.4 SD-06 Test Reports

a. Tests, Inspections, and Verifications

(1) Mechanical butt-splices: Submit test reports or verification that proposed mechanical butt-splice devices develop the specified strength of the spliced reinforcing bar.

(2) Certified tests reports of reinforcement steel used in welded applications showing the steel complies with the applicable specifications shall be furnished for each steel shipment and identified with specific lots prior to placement. Three copies of the heat analyses shall be provided for each lot of steel furnished and the Contractor shall certify that the steel conforms to the heat analyses.

1.2.1.5 SD-07 Certificates

a. Epoxy-Coated Steel Bars

(1) Written certification for coating material and coated bars shall be submitted with the delivery of the bars.

b. Qualification of Welders

(1) Certificates on the Qualifications of welders performing Steel Bar Butt-Splices shall be submitted prior to commencing butt-splicing.

1.3 WELDING

1.3.1 Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.

1.4 DELIVERY AND STORAGE

1.4.1 Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Materials shall conform to the following requirements.

2.1.1.1 Steel Bars

a. Steel bars shall comply with the requirements of ASTM A 615 or ASTM A 706, deformed, of the grades, sizes and lengths shown. Reinforcing bars shall be Grade 60 unless noted otherwise. If the Grade 40 bars shown are unavailable the Contractor may substitute Grade 60 bars of the same size and spacing as indicated for Grade 40 bars when authorized. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82.

b. In highly corrosive environments, or when directed by the Contracting Officer, reinforcing steel shall be zinc-coated (galvanized) or epoxy-coated as appropriate.

2.1.1.2 Zinc-Coated (Galvanized) Bars

a. Zinc-coated (galvanized) bars shall comply with the requirements of ASTM A 767, Class II (2.0 oz. zinc psf), hot-dip galvanized after fabrication.

2.1.1.3 Epoxy-Coated Bars

a. Epoxy-coated steel bars shall comply with the requirements of ASTM A 775, including written certifications for coating material and coated bars, sample of coating material, and 0.5 pounds of patching material.

2.1.1.4 Mechanical Butt-Splices

a. Mechanical reinforcing bar butt-splicing devices shall be an approved exothermic, threaded coupling, swaged sleeve or other positive connecting type. The splicing device shall be capable of developing the 125 percent of the specified minimum ultimate tensile strength of the smallest bar of the splice, and, the additional deformation of number 14 and smaller bars due to slippage or other movement within the splice sleeve shall not exceed 0.015 inches (unit strain 0.0015 inches/inch) beyond the elongation of an unspliced bar based upon a 10 inch gage length spanning the extremities of the sleeve at a stress of 30,000 psi. The additional deformation of number 18 bars shall not exceed 0.03 inches (unit strain 0.003 inches/inch) beyond the elongation of an unspliced bar based upon a 10 inch gage length spanning the extremities of the sleeve at a stress of 30,000 psi. The amount of the additional deformation shall be determined from the stress-strain curves of the unspliced and spliced bars tested as required paragraph QUALIFICATION OF BUTT-SPLICING PROCEDURE for qualification of the butt-splicing procedure.

2.1.1.5 Fabricated Bar Mats

a. Fabricated bar mats shall comply with the requirements of ASTM A 184, clipped or welded mats, bar sizes and spacing as shown.

2.1.1.6 Steel Welded Wire Fabric

a. Steel welded wire fabric shall comply with the requirements of ASTM A 185 or ASTM A 497 wire sizes and spacing as shown.

b. In highly corrosive environments, or when directed by the Contracting Officer, welded wire fabric shall be epoxy-coated conforming to ASTM A 884.

2.1.2 Accessories

2.1.2.1 Bar Supports

a. Bar supports shall comply with the requirements of ACI 301. Where concrete formed surfaces will be exposed to view or weather or will be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. For slabs on grade or foundation elements poured over grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates or specially designed wire-fabric supports fabricated of plastic. Precast concrete supports shall be wedged-shaped, not larger than 3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover, have an embedded hooked tie-wire for anchorage and have a compressive strength equal to that of the surrounding concrete.

2.1.2.2 Wire Ties

a. Wire ties shall be 16 gage or heavier black annealed wire. Ties for epoxy-coated bars shall be vinyl-coated or epoxy-coated. Ties for zinc-coated bars shall be zinc-coated.

2.2 SYNTHETIC FIBER REINFORCEMENT

2.2.1 Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inches.

2.3 TESTS, INSPECTIONS AND VERIFICATIONS

2.3.1 The Contractor shall have material tests required by applicable standards and specified performed by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Tests, inspections, and verifications shall be performed and certified at the Contractor's expense.

2.3.1.1 Qualification of Welders

a. Qualification of welders performing steel bar butt-splices shall be certified to have satisfactorily completed a course of instruction in the proposed method of butt-splicing or have satisfactorily performed such work within the preceding year.

2.3.1.2 Qualification of Butt-Splicing Procedure

a. As a condition of approval of the butt-splicing procedure, the Contractor, in the presence of the Contracting Officer, shall make three test butt-splices of steel bars of each size to be spliced using the proposed butt-splicing method. These test butt-splices and unspliced bars of the same size shall be tension tested to destruction with stress-strain curves plotted for each test. Test results must show that the butt-splices meet the specified strength and deformation requirements in order for the splicing procedure to be approved.

2.3.1.3 Radiographic Examination of Welds

a. Radiographic examination of welds shall be in accordance with ASTM E 94 and shall be performed and evaluated by an approved testing agency adequately equipped to perform such services. Radiographs of welds and evaluations of the radiographs submitted for approval shall become the property of the Government.

PART 3 EXECUTION

3.1 REINFORCEMENT

3.1.1 Reinforcement shall be fabricated to shapes and dimensions shown on the approved shop drawings in conformance with the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. All bending of epoxy and zinc-coated reinforcing shall be performed prior to coating and shall be accomplished at the mill. Uncoated reinforcing shall be bent at the mill unless authorized by the Contracting Officer to be performed in the field. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete.

3.1.1.1 Welding

a. Welding of reinforcing steel will be permitted only where indicated or authorized. Contractor shall receive and have present a current burn permit for all welding. Welding shall be in accordance with AWS D1.4 except where otherwise specified or indicated.

3.1.1.2 Placement

a. Reinforcement shall be placed and supported in accordance with ACI 318/318R at locations shown on the shop drawings. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than 1 inch.

b. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.1.3 Splicing

a. Splices of reinforcement shall conform to ACI 318 and shall be made only as required or as indicated. Bars may be spliced at alternate or additional locations at no additional cost to the Government subject to approval.

b. Lap splices shall be used only for bars smaller than size 14. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 1/5 the required length of lap or 6 inches.

c. Butt-splices shall be used only for splicing size 14 and 18 bars and for splicing #11 bars to larger bars except where otherwise shown or authorized. Butt splices can be welded or mechanical splices. Bars shall be cleaned of all oil, grease, dirt, rust, scale and other foreign substances and shall be flame dried before splicing. Adequate jigs and clamps or other devices shall be provided to support, align and hold the longitudinal centerline of the bars to be butt-spliced in a straight line. Butt-splices shall be as follows:

(1) Welded butt-splices shall be performed in accordance with the approved procedure unless otherwise authorized by the Contracting Officer and shall be full penetration butt welds. Bars used in welded splices shall be restricted to steel shown by heat analysis to have a sulfur content not exceeding 0.05 percent. The ends of bars to be welded shall be prepared in accordance with the approved butt-welding procedure. Tension splices of number 14 or smaller bar shall be staggered longitudinally a minimum of 5 feet or as otherwise indicated so that no more than half of the bars are spliced at any one section. Tension splices of number 18 bars shall be staggered longitudinally a minimum of 5 feet so that no more than 1/3 of the bars are spliced at any one section.

(2) Mechanical Splices: Bars to be spliced by a mechanical butt-splicing process may be sawed, sheared or flame cut provided the ends of sheared bars are reshaped after shearing and all slag is removed from the ends of flame cut bars by chipping and wire brushing prior to splicing. Surfaces to be enclosed within a splice sleeve or coupling shall be cleaned by wire brushing or other approved method prior to splicing. Splices shall be made using manufacturer's standard jigs, clamps, ignition devices and other required accessories. Tension splices of number 14 or smaller bar shall be staggered longitudinally a minimum of 5 feet or as otherwise indicated so that no more than half of the bars are spliced at any one section. Tension splices of number 18 bars shall be staggered longitudinally a minimum of 5 feet so that no more than 1/3 of the bars are spliced at any one section.

3.1.2 Concrete cover to reinforcement shall be in accordance with ACI 318 unless shown otherwise on the drawings with the following tolerances for minimum cover:

MINIMUM COVER	VARIATION
6 inch	plus 1/2 inch
4 inch	plus 3/8 inch
3 inch	plus 3/8 inch
2 inch	plus 1/4 inch
1-1/2 inch	plus 1/4 inch
1 inch	plus 1/8 inch
3/4 inch	plus 1/8 inch

3.2 WELDED-WIRE FABRIC PLACEMENT

3.2.1 Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated.

3.2.2 Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWEL INSTALLATION FOR SLABS ON GRADE

3.3.1 Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

3.4 SYNTHETIC FIBER REINFORCED CONCRETE

3.4.1 Fiber reinforcement shall be added to the concrete mix in accordance with the applicable sections of ASTM C 1116 and the recommendations of the manufacturer, at a minimum amount of 3.5 lbs. per cubic yard of concrete.

3.5 FIELD TESTS AND INSPECTIONS

3.5.1 Reinforcement

3.5.1.1 Concrete reinforcing shall be inspected prior to closing of concrete formwork or placing of concrete. Inspect all reinforcing for conformance to Contract requirements. Written reports shall be submitted of all inspections on a daily basis. Such reports shall include a description of each area inspected, deficiencies noted, and corrective action undertaken to resolve such deficiencies. Deficiencies observed shall immediately be brought to the attention of the Contractor's Field Superintendent and Reinforcing Placer's Foreman.

3.5.1.2 Butt-splices: All butt-splices shall be marked in the field and shall identify the splicer who performed the work.

a. The contractor shall perform the following during the butt-splicing operations as specified and as directed:

(1) Visual Examination - All welded splices shall be visually examined for the presence of cracks, undercuts, inadequate size and other visible defects. Respliced connections resulting from correction of visual defects may be radiographically examined at the option of the Contracting Officer as specified in paragraph SUPPLEMENTAL EXAMINATION. Mechanical butt-splices shall be visually examined to determine if the splice has been correctly completed according to the manufacturer’s directions.

(2) Tension Tests - Tension tests to 90 percent of the minimum specified ultimate tensile strength of the spliced bars or to destruction shall be performed on one test specimen made in the field for every 25 welded splices made. Test specimens shall be made by the splicers engaged in the work, using the approved splicing procedure and the same size bars placed in the same relative position, and under the same conditions as those in the groups represented by the specimens. Stress-strain curves shall be furnished for each butt-splice tested.

(3) Radiographic Examination - Not less than one of each 25 welded splices selected at random by the Contracting Officer shall be examined radiographically and evaluated for defects. The greatest dimension of any porosity (gas pocket or similar void) or fusion-type defect (slag inclusion, incomplete fusion or similar generally elongated defect in weld fusion) shall not exceed 1/4 inch. The minimum clearance between edges of porosity or fusion-type defects shall not be less than 1 inch.

(4) Correction of Deficiencies - No splice shall be embedded in concrete until satisfactory results of visual examination and the required tests or examinations have been obtained. All splices having visible defects or represented by test specimens which do not satisfy the tests or examinations shall be removed. If any of the tension test specimens fail to meet the strength requirements or deformation limitations two production splices from the same lot represented by the test specimens which failed shall be cut out and tension tested by the Contractor. If both of the retests pass the strength requirements and deformation limitations all of the splices in the lot will be accepted. If one or both of the retests fail to meet the strength requirements or deformation limitations all of the splices in the lot will be rejected. All costs of removal, testing and resplicing of the additional production splices shall be borne by the Contractor. The bars of rejected splices shall be cut off outside the splice zone of weld metal, filler metal contact, coupling or sleeve. The cut ends shall be finished as specified and the joints shall be respliced and reinspected at no additional cost.

(5) Supplemental Examination - The Contracting Officer may require additional or supplemental radiographic examination and/or tension test of any completed splice.

3.6 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

3.6.1 Special inspections and testing for seismic-resisting systems and components shall be done as indicated on the drawings and in accordance with UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS.

**** END OF SECTION ****

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Footings.
2. Foundations (walls and pilasters)
3. Slabs-on-grade.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

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

1. Include data substantiating that materials comply with requirements.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Concrete materials representing current production shall be tested and used to fabricate trial mix data. The testing lab shall submit and certify the results of all tests and/or certificates of all materials and calculations used to develop the 7-day and 28-day compressive strength test results and applicable reference specifications.

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 according to ACI 315 “Details and Detailing of Concrete Reinforcement”. 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. Include special reinforcement required for openings through concrete structures.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Contracting Officer. Do not proceed with work unless construction joint shop drawings are approved by Owner.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. manufacturer and testing agency.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.
15. Structural epoxy for reinforcing.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.

C. 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."

D. 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, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

F. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

I. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.

b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete subcontractor.
e. Special concrete finish subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Damaged or non-conforming materials shall be removed from the Project Site and replaced with new satisfactory materials at no additional cost to Owner.

C. Deliver packaged materials to Project Site in original, unopened and undamaged containers plainly labeled with manufacturer's name, product name and designation, expiration period for use, mixing instructions for multi-component materials and other pertinent data. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage and other causes.

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:

a. High-density overlay, Class 1 or better.
b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
c. Structural 1, B-B or better; mill oiled and edge sealed.
d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

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. 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.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

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

2.4 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/II, gray. Supplement with the following:

a. Fly Ash: ASTM C 618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch 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.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

H. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Two-component, semirigid, 100 percent solids epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-componenet epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.9 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 50 percent.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.11 FABRICATING REINFORCEMENT

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

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

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, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces,

2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Chamfer exterior corners and edges of permanently exposed concrete and do not chamfer edges of concrete inside firing range.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. 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 required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. 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. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Contracting Officer.

1. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
2. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated and as approved by Contracting Officer. 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. 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- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. 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.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 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. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Contracting Officer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. 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. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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

3.8 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 indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

2. Finish surfaces to the following tolerances, according to ASTM E 1155/e 1155M, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
3. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, mechanical yards, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Contracting Officer before application.

3.9 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: 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.

3.10 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 approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.11 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.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Contracting Officer. Remove and replace concrete that cannot be repaired and patched to Contracting Officer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of

cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Contracting Officer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Contracting Officer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Contracting Officer's approval.

3.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: Contracting Officer will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel reinforcement placement.
2. Headed bolts and studs.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. 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 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.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, 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, and one test for each composite sample.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.

b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
10. Test results shall be reported in writing to Contracting Officer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Contracting Officer but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Contracting Officer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Contracting Officer.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

**** END OF SECTION ****

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Structure

1.1.1.1 Payment

Payment will be made for costs associated with operations necessary for construction of the structure at Dyess AFB, Building 8040.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Concrete for entire project

1.1.2.1 Payment

Payment will be made for costs associated with completing the concrete work for concrete placed on the Project. However, these costs will not include the cost of embedded parts that are specified to be paid for separately. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

1.1.2.2 Measurement

Concrete will be measured for payment based upon the actual volume of concrete within the pay lines of the structures as indicated on the drawings. Measure concrete placed against the sides of any excavation without the use of intervening forms only within the pay lines of the structure. Make no deductions for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, or for voids or embedded items that are either less than 0.14 cubic meters (5 cubic feet) in volume or 0.09 square meter (1 square foot) in cross section.

1.1.2.3 Unit of Measure

Unit of measure: cubic meters (yards).

1.2 REFERENCES

publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2010; ERTA 2015) Specifications for Structural Concrete
ACI 301M	(2010; ERTA 2015) Metric Specifications for Structural Concrete

ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306R	(2010) Guide to Cold Weather Concreting
ACI SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2016a) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2011) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2016) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2011) Standard Specification for Hydraulic Cement
ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2014) Standard Test Method for Lightweight Particles in Aggregate
ASTM C1240	(2014) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2015a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2016) Standard Specification for Portland Cement
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C172/C172M	(2014a) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2014) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2012) Petrographic Examination of Aggregates for Concrete
ASTM C31/C31M	(2015a; E 2016) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2016) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C441	(2011) Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2015a) Standard Specification for Chemical Admixtures for Concrete

ASTM C535	(2012) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2016) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C87/C87M	(2010) Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2016) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2014) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM E1155	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1155M	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers (Metric)

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2009; 28th Ed) Manual of Standard Practice

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2013) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate

COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders

1.3 DESIGN REQUIREMENTS

Design in accordance with ACI 301M (ACI 301), Section 4. Submit concrete mix designs with the following properties.

1.3.1 Air Content

Air content between 4 and 7 percent as delivered to the forms and as determined by ASTM C231/C231M, except that when the nominal maximum-size coarse aggregate is 19.0 mm (3/4 inch), between 4.5 and 7.5 percent.

1.3.2 Slump

The slump within the range of 25 to 100 mm (1 to 4 inches) as determined in accordance with ASTM C143/C143M. Where placement by pump is approved, the slump must not exceed 150 mm (6 inches). Concrete to be placed in footings, grade beams and slabs-on-grade may contain a chemical admixture for use in producing flowing concrete in accordance with ASTM C1017/C1017M, and the slump of the concrete must not exceed 200 mm (8 inches).

1.3.3 Concrete Strength

Provide specified compressive strength f'c as follows:

COMPRESSIVE STRENGTH (MPa) (PSI)	STRUCTURE OR PORTION OF STRUCTURE
27.6 @ 28 days 4,000 @ 28 days	Footing and slabs-on-grade
30.1 @ 28 days 4,500 @ 28 days	Foundations (walls and pilasters)

1.3.4 Maximum Water-Cementitious Material (W/C) Ratio

Maximum W/C allowed as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.45	All elements

These W/C's may cause higher strengths than that required by paragraph CONCRETE STRENGTH.

1.3.5 Construction Tolerances

Except as specified otherwise, a plus tolerance increases and a minus tolerance decreases the dimension to which it applies. A tolerance without sign means plus or minus. Where only one sign is specified, there is no limit in the other direction. Tolerances are not cumulative. The most restrictive tolerance will control. Tolerances can not extend the structure beyond legal boundaries.

a. Make level and grade tolerance measurements of slabs as soon as possible after finishing. When forms or shoring are used, make the measurements prior to removal.

b. Construction tolerances must meet the requirements of ACI 117 and any of the following requirements that are applicable.

1.3.5.1 Formed Concrete Surfaces

For High Velocity flow, Class A-HV-Abrupt variation, a positive offset between concrete surfaces is a raise of elevation in the direction of water flow and a negative offset is a drop of elevation in the direction of the water flow.

Direction of water flow	+0 mm 0 inches
	-3 mm 1/8 inch
Perpendicular to the direction of water flow	3 mm 1/8 inch

1.3.5.2 Floor Finish by the F-Number System

Carefully control the flatness and levelness of the floors in the following listed areas and measure the tolerances by the F-Number system:

Floor Flatness (FF) All areas: 20 minimum
Floor Levelness (FL) All areas: 15 minimum

Furnish a floor profilograph or other equipment capable of measuring the floor flatness (FF) number and the floor levelness (FL) number, in accordance with ASTM E1155M (ASTM E1155). Perform the tolerance measurements while being observed by the Contracting Officer. Special finishing procedures and special care will be required to meet these tolerances.

1.3.5.3 Appearance

Clean permanently exposed surfaces, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcing steel; G

SD-03 Product Data

Concrete Mix Designs; G
Batch Plant; G
Concrete Mixers
Conveying Equipment
Placing Equipment
Construction Joint Treatment; G
Cold-Weather Requirements; G
Hot-Weather Requirements; G
Cementitious Materials, Admixtures, and Curing Compound; G
Nonshrink Grout
Mechanical Reinforcing Bar Connectors

SD-06 Test Reports

Aggregates; G
Mill Test Reports
Tests and Inspections
Quality of Aggregates; G
[Mixer Uniformity]
Water

SD-07 Certificates

Concrete Field Testing Technicians
Concrete Construction Inspector (CCI)
Cementitious Materials
Blended Hydraulic Cement

SD-08 Manufacturer's Instructions

Curing Compound

1.5 QUALITY ASSURANCE

The Government will sample and test aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D75/D75M. Concrete will be sampled in accordance with ASTM C172/C172M. Do not use a material until the Contracting Officer gives notice that test results are satisfactory The individuals who sample

and test concrete or the constituents of concrete as required in this specification must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete construction must have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector (CCI). Submit statements that the concrete testing technicians and the concrete inspectors meet the specified requirements. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

1.5.1 Cement and Pozzolan

If cement or pozzolan is to be obtained from more than one source, state the estimated amount to be obtained from each source and the proposed schedule of shipments in the initial notification.

1.5.1.1 Prequalified Cement Sources

Deliver and use cement directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete-producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement sources is available from Director, U.S. Army Corps of Engineers, Engineer Research and Development Center - Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEERD-SC.

1.5.1.2 Prequalified Pozzolan Sources

Deliver and use pozzolan directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Director, U.S. Army Corps of Engineers, Engineer Research and Development Center - Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEERD-SC.

1.5.1.3 Nonprequalified Cement Sources

Cement, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of testing. Sampling, testing, and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made by or under the supervision of the Government and at its expense. Do not use cement until the Contracting Officer gives that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request and expense of the Contractor. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense.

1.5.1.4 Nonprequalified Pozzolan Sources

Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical and chemical and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and

approval for use on the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event the pozzolan may be sampled as it is loaded into cars, trucks, or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, Promptly remove it from the site of the work. Retest pozzolan that has not been used within 6 months after testing when directed by the Contracting Officer and rejectthe pozzolan if the test results are not satisfactory.

1.5.2 Cementitious Materials, Admixtures, and Curing Compound

At least 60 days in advance of concrete placement, notify the Contracting Officer of the sources for cementitious materials, admixtures, and curing compound, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete. Cementitious Materials, including Cement and Pozzolan, [and Ground Granulated Blast-Furnace Slag] will be accepted on the basis of the manufacturer's certification of compliance. Do not use cementitious materials until receiving Contracting Officer notice of acceptance. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Promptly remove material not meeting specifications from the site of work. Submit samples of materials for Government testing and approval. Submit manufacturer's instructions for placement of curing compound.

1.6 DELIVERY, STORAGE, AND HANDLING

Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing and reject if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements of paragraph CHEMICAL ADMIXTURES.

PART 2 PRODUCTS

2.1 MATERIALS

Submit mill test reports attesting that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports must be from samples taken from the particular lot furnished. Certify the following for compliance with all specification requirements: Impervious-Sheet Curing Materials, Air-Entraining Admixture, Other Chemical Admixtures, Membrane-Forming Curing Compound. Submit descriptive literature of the Nonshrink Grout proposed for use together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered.

2.1.1 Cementitious Materials

Cementitious materials are portland cement, portland-pozzolan cement, portland blast-furnace slag cement, portland cement in combination with pozzolan or GGBF slag or portland cement in combination with silica fume conforming to appropriate specifications listed below. Restrict the use of cementitious materials in architectural concrete to one color, one source, and one type.

2.1.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of C3A in Type I cement is 15 percent In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a pozzolan or GGBF slag provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441 must be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in general conformance with ASTM C441. Run the expansion tests concurrently at an independent laboratory that is nationally recognized to perform such tests. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or slag in the combination to suit other requirements. white portland cement must meet the above requirements except that it may be Type I, Type II, or Type III . White Type III may be used only in specific areas of the structure, when approved in writing by the Contracting Officer.

2.1.1.2 High-Early-Strength Portland Cement

ASTM C150/C150M, Type III, with C3A limited to 8 percentused only when specifically approved in writing.

2.1.1.3 Fly Ash

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 6 percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 8 percent and a total equivalent alkali content less than 1.5 percent. Add with cement.

2.1.1.4 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have an ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

2.1.1.5 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age is at least 95 percent of the control specimens.

b. The average particle size doest not exceed 6 μm (6 microns).

c. The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ is greater than 77 percent.

2.1.1.6 Ground Granulated Blast-Furnace Slag

Conform to ASTM C989/C989M, Grade 100 or 120.

2.1.1.7 Silica Fume

Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, must conform to ASTM C1240 with Table 2 and the Specific Surface Area and Uniformity Requirements in Table 4 invoked. Provide the services of a

manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. Make the manufacturer's representative available for consultation by both the Contractor and the Government during mixture proportioning, planning, and production of silica-fume concrete and, onsite immediately prior to and during at least the first placement of concrete containing silica fume, and at other times if directed.

2.1.1.8 Blended Hydraulic Cement

Conform to ASTM C595/C595M and ASTM C1157/C1157M, Type IP or IS, including the optional requirement for mortar expansion and sulfate soundness and consist of a mixture of ASTM C150/C150M Type I, or Type II cement and a complementary cementing material. Provide slag added to the Type IS blend conforming to ASTM C989/C989M ground granulated blast-furnace slag. Use pozzolan added to the Type IP blend conforming ASTM C618 Class F and interground with the cement clinker. Provide the manufacturer's written statement that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of mineral admixture used in the blend cannot change from that submitted for the aggregate evaluation and mixture proportioning.

2.1.2 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement. Submit test report showing compliance with ASTM C33/C33M.

2.1.2.1 Aggregate Expansion

Provide fine and coarse aggregates with expansions less than 0.08 percent at 28 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 and using the proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

a. GGBF slag at a minimum of 40 percent of total cementitious

b. Fly ash or natural pozzolan at a minimum of total cementitious of

(1) 30 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 65 percent or more,
(2) 25 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 70 percent or more,
(3) 20 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 80 percent or more,
(4) 15 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 90 percent or more.

c. Silica fume at a minimum of 7 percent of total cementitious.

If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 16 days after casting when tested in accordance with ASTM C1567.

2.1.2.2 Unfavorable Properties

Do not provide aggregates possessing properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

2.1.3 Chemical Admixtures

Provide chemical admixtures, when required or permitted, that conform to the appropriate specification listed.

2.1.3.1 Air-Entraining Admixture

Conform to ASTM C260/C260M and consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.3.2 Accelerating Admixture

Meet the requirements of ASTM C494/C494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride is not permitted.

2.1.3.3 Water-Reducing or Retarding Admixture

2.1.3.3.1 Water-Reducing or Retarding Admixtures

ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

2.1.3.3.2 High-Range Water Reducing Admixture

ASTM C494/C494M, Type F or G except that the 6-month and 1-year strength requirements are waived. The admixture may be used only when approved by the Contracting Officer, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

2.1.3.4 Other Chemical Admixtures

Provide other chemical admixtures for use in producing flowing concrete in compliance with ASTM C1017/C1017M, Type 1 or 2. Only use these admixture for concrete listed in paragraph SLUMP.

2.1.4 Water

Provide water for mixing and curing compliance with the requirements of ASTM C1602/C1602M; potable, and free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

2.1.5 Reinforcing Steel

Provide reinforcing bars conforming to the requirements of ASTM A615/A615M, Grade 60, deformed. Welded steel wire reinforcement must conform to the requirements of ASTM A1064/A1064M. Detail reinforcement not indicated in accordance with ACI 301M (ACI 301). Provide mechanical reinforcing bar connectors in accordance with ACI 301 and with 125 percent minimum yield strength of the reinforcement bar.

2.1.6 Nonshrink Grout

Cconform to ASTM C1107/C1107M and a commercial formulation suitable for the application proposed.

2.1.7 Abrasive Aggregates

Fifty-five percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. Provide well graded aggregate from particles retained on the 600-µm (No. 30) sieve to particles passing the 2.36-mm (No. 8) sieve.

2.2 EQUIPMENT

Submit data on placing equipment and methods. The batching, mixing, conveying, and placing equipment must have a capacity of at least 75 cubic meters (yards) per hour. Conform the batch plant to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required. Submit batch plant data forconformance with applicable specifications.

2.2.1 Batching Equipment

Use partially automatic, semiautomatic], or automatic batching controls. Provide the semiautomatic batching system with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. Equip the batching system with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Provide separate bins or compartments for each size group of aggregate and cement, pozzolan, and GGBF slag. Weigh aggregates either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Do not weigh aggregate in the same batcher with cement, pozzolan, or GGBF slag. If both cement and pozzolan or GGBF slag are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, do not weigh the mass of the water cumulatively with another ingredient. Interlock water batcher filling and discharging valves so that the discharge valve cannot be opened before the filling valve is fully closed. Provide an accurate mechanical device for measuring and dispensing each admixtured. Interlock each dispenser with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Do not combine admixtures prior to introduction in water. Arrange the plant to facilitate the inspection of all operations at all times. Provide facilities for obtaining representative samples of aggregates from each bin or compartment. Clearly mark all filling ports for cementitious materials bins or silos with a permanent sign stating the contents.

2.2.2 Scales

Provide equipment for batching by mass conforming to the applicable requirements of NIST HB 44, except that the accuracy is plus or minus 0.2 percent of scale capacity. Provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Perform tests at the frequency required in paragraph TESTS AND INSPECTIONS, and in the presence of a Government inspector.

2.2.3 Batching Tolerances

a. Weighing Tolerances

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

b. Volumetric Tolerances - For volumetric batching equipment, the following tolerances apply to the required volume of material being batched:

Water	Plus or minus 1 percent
Chemical admixtures	Zero to plus 6 percent

2.2.4 Moisture Control

The plant must be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring moisture in the fine aggregate. Arrange the sensing element so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

2.2.5 Concrete Mixers

Do not charge the concrete mixers in excess of the capacity recommended by the manufacturer. Operate the mixers at the drum or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operating condition, and keep the mixer drums free of hardened concrete. Should any mixer at any time produce unsatisfactory results, promptly discontinue its use until it is repaired. Submit concrete mixer data including the make, type, and capacity of concrete mixers proposed for mixing concrete.

2.2.5.1 Stationary Mixers

Concrete plant mixers must be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity must conform to all the requirements in ASTM C94/C94M applicable to central-mixed concrete.

2.2.5.2 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity must conform to the requirements of ASTM C94/C94M. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Equip each truck with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

2.2.6 Conveying Equipment

Submit data on the conveying equipment and methods for transporting, handling, and depositing the concrete. Conform the conveying equipment to the following requirements:

2.2.6.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 0.2 square meters (2 square feet). The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 1.5 cubic meters (2 cubic yards) shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

2.2.6.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers must be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. Equip the transfer hopper with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Do not hold concrete in nonagitating transfer hoppers more than 30 minutes.

2.2.6.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C94/C94M. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

2.2.6.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. Use a discharge deflector when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

2.2.6.5 Belt Conveyors

Design and operate to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and provide with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Construct belt conveyors such that the idler spacing does not exceed 900 mm (36 inches). The belt speed must be a minimum of 90 m (300 feet) per minute and a maximum of 230 m (750 feet) per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, discharge the conveyor concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

2.2.6.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment must be piston or squeeze pressure. The pipeline must be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe must be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 100 mm (4 inches). Do not use aluminum pipe.

2.2.7 Vibrators

Use vibrators of the proper size, frequency, and amplitude for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER (mm (inches)	FREQUENCY (VPM)	AMPLITUDE (mm (inches)
Thin walls, beams, etc.	32 to 641-1/4 to 2-1/2	9,000 to 13,500	0.5 to 1.00.02 to 0.04
General construction	50 to 882 to 3-1/2	8,000 to 12,000	0.6 to 1.20.025 to 0.05

Determine the frequency and amplitude in accordance with COE CRD-C 521.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

3.1.1 Embedded Items

Before placement of concrete, take care to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items must be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Temproarily fill voids in sleeves, inserts, and anchor slots with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 600 mm (2 feet) of the surface of the concrete.

3.1.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed must be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, compact the earth foundation in accordance with Section 31 00 00 EARTHWORK.

3.1.3 Concrete on Rock Foundations

Rock surfaces upon which concrete is to be placed mustl be clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Clean joints in rock to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the concrete is placed, thoroughly clean all rock surfaces by the use of air-water jets or sandblasting as described in paragraph CONSTRUCTION JOINT TREATMENT. Keep all rock surfaces continuously wet for at least 24 hours immediately prior to placing concrete thereon. Cover all approximately horizontal surfaces immediately before the concrete is placed with a layer of

mortar proportioned similar to that in the concrete mixture. Cover the mortar with concrete before the time of initial setting of the mortar.

3.1.4 Construction Joint Treatment

Submit the method and equipment proposed for joint cleanup and waste disposal, for review and approval. Conform construction joint treatment to the following requirements:

3.1.4.1 Joint Preparation

Prepare concrete surfaces to which additional concrete is to be bonded for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces must be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. Do not undercut the edges of the coarse aggregate. Wash the surface again as the last operation prior to placing the next lift. No standing water is allowed on the surface upon which concrete is placed.

3.1.4.2 Air-Water Cutting

Perform air-water cutting of a construction joint at the proper time and only on horizontal construction joints. The air pressure used in the jet must be 620 to 760 kPa (90 to 110 psi), and the water pressure must be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, furnish samples of the material to be used and demonstrate the method to be used in applications. After cutting, wash and rinse the surface long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.1.4.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 20.7 MPa (3,000 psi) may be used for cleaning. Delay its use until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, clean the surface by sandblasting.

3.1.4.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. Then thoroughly wash the surface of the concrete to remove all loose materials.

3.1.4.5 Waste Disposal

Dispose of the waste water employed in cutting, washing, and rinsing of concrete surfaces such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal is subject to approval.

3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301M (ACI 301), Section 5. Do not reconstitute concrete that has begun to solidify.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R.

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R.

3.3 SETTING BASE PLATES AND BEARING PLATES

3.3.1 Setting of Plates

After being plumbed and properly positioned, provide column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates with full bearing with nonshrink grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate must be approximately 1/24 of the width of the plate, but not less than 13 mm (1/2 inch) for plates less than 300 mm (12 inches) wide. Concrete surfaces must be rough, clean, and free of oil, grease, and laitance, and damp. Clean metal surfaces free of oil, grease, and rust.

3.3.2 Nonshrink Grout Application

Water content must be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.3.2.1 Mixing and Placing of Nonshrink Grout

Mix and place in accordance with the material manufacturer's instructions and as specified. Thoroughly dry-mix ingredients before adding water. After adding water, mix the batch for 3 minutes. Size batches to allow continuous placement of freshly mixed grout. Discard grout not used within 30 minutes after mixing. Fill the space between the top of the concrete or masonry-bearing surface and the plate solid with the grout. Use forms of wood or other equally suitable material for retaining the grout and remove after the grout has set. If grade "A" grout as specified in ASTM C1107/C1107M is used, form all surfaces to provide restraint. Work the placed grout to eliminate voids; however, avoid overworking and breakdown of the initial set. Do not be retemper or subject grout to vibration from any source. Where clearances are unusually small, place under pressure with a grout pump. Maintain temperature of the grout, and of surfaces receiving the grout, at 20 to 30 degrees C (65 to 85 degrees F) until after setting.

3.3.2.2 Treatment of Exposed Surfaces

After the grout has set, cut back the exposed surfaces of those types containing metallic aggregate 25 mm (1 inch) and immediately cover with a parge coat of mortar proportioned by mass of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat must have a smooth, dense finish. The exposed surface of other types of nonshrink grout must have a smooth, dense finish.

3.3.2.3 Curing

Cure grout and parge coats in accordance with Section 03 39 00.00 10.

3.4 TESTS AND INSPECTIONS

Submit test results and inspection reports, daily and weekly. Tests and inspect in accordance the following:

3.4.1 General

Perform the inspections and tests described below, and, based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, cease concrete placement. Locate the laboratory performing the tests on site and conform with ASTM C1077. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.4.2 Testing and Inspection Requirements

3.4.2.1 Fine Aggregate

3.4.2.1.1 Grading

At least once during each shift when the concrete plant is operating, perform one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

3.4.2.1.2 Corrective Action for Fine Aggregate Grading

When the amount passing on any sieve is outside the specification limits, immediately resample and retest the fine aggregate. If there is another failure on any sieve, immediately be report to the Contracting Officer.

3.4.2.1.3 Moisture Content Testing

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Randomly select the times for the tests within the 8-hour period. Make an additional test whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, make at least two direct measurements of moisture content per week to check the calibration of the meter. Use the results of tests for moisture content to adjust the added water in the control of the batch plant.

3.4.2.1.4 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, adjust the scale settings for the fine-aggregate batcher and water batcher (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.4.2.2 Coarse Aggregate

3.4.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, conduct a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.

3.4.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, consider the operation out of control and report to the Contracting Officer. Stop concreting and take immediate steps to correct the grading.

3.4.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate at least twice per week. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, increase frequency of testing to that specified above for fine aggregate, until the difference falls below 1.0 percent.

3.4.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, adjust the scale setting for the coarse aggregate batcher and the water batcher if necessary to maintain the specified slump.

3.4.2.3 Quality of Aggregates

Submit aggregate quality tests at least 30 days prior to start of concrete placement.

3.4.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of concrete placement, perform all tests for aggregate quality listed below. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule shown below. Take amples tested after the start of concrete placement immediately prior to entering the concrete mixer.

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Durability Factor (using Procedure A)	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than 75-m No. 200 Sieve	Not applicable	Every 3 months	ASTM C117
Impurities	Every 3 months	Not applicable	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Chert, less than 2.40 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M
Coal and Lignite, less than less than 2.00 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M

3.4.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, change production procedures or materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, immediately rerun the test. If the second test fails the quality requirement, report the fact to the Contracting Officer and take immediate steps to rectify the situation.

3.4.2.4 Scales

3.4.2.4.1 Weighing Accuracy

Check the accuracy of the scales by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Also make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.4.2.4.2 Batching and Recording Accuracy

Once a week check the accuracy of each batching and recording device during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. Confirm that the calibration devices described in paragraph EQUIPMENT, for checking the accuracy of dispensed admixtures, are operating properly.

3.4.2.4.3 Scales Corrective Action

When either the weighing accuracy or batching accuracy does not comply with specification requirements, do not operate the plant until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately.

3.4.2.5 Batch-Plant Control

Continuously control the measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures. Adjust the aggregate weights and amount of added water as necessary to compensate for free moisture in the aggregates. Adjust the amount of air-entraining agent to control air content within specified limits. Prepare a report indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic meter (yard), amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic meter (yard) for each class of concrete batched during plant operation.

3.4.2.6 Concrete Mixture

3.4.2.6.1 Air Content Testing

Conduct air content tests when test specimens are fabricated. In addition, make at least two tests for air content on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Make additional tests when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Conduct tests in accordance with ASTM C231/C231M. Plot test results on control charts which at all times are readily available to the Government.[Keep copies of the current control charts in the field, by the Contractor's quality control representatives, and plotted results as tests are made. When a single test result reaches either the upper or lower action limit immediately conduct a second test. Average the results of the two tests and use this average as the air content of the batch to plot on both the control chart for air content and the control chart for range, and for determining the need for any remedial action. Plot the result of each test, or average as noted in the previous sentence, on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph AIR CONTENT. Set an upper warning limit and a lower warning limit line 1.0 percentage point above and below the average line. Set an upper action limit and a lower action limit line 1.5 percentage points above and below the average line, respectively. Plot the range between each two consecutive tests on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content.

If the materials or transportation methods cause air content loss between the mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the air content at the mixer as directed.

3.4.2.6.2 Air Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, immediately adjust the amount of air-entraining admixture batched. As soon as is practical after each adjustment, conduct another test to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, recalibrate the admixture dispenser to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content is considered out of control and immediately halt the concreting operation until the air content is under control. Make additional air content tests when concreting is restarted.

3.4.2.6.3 Slump Testing

In addition to slump tests made when test specimens are fabricated, make at least four slump tests on randomly selected batches in accordance with ASTM C143/C143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, make additional tests shall when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Plot test results on control charts, which are readily available to the Government at all times. Keep copies of the current control charts in the field by the Contractor's quality control representatives and plot results as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, immediately make a second test on the same batch of concrete. Average the results of the two tests and use this average as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. Set an upper warning limit at 13 mm (1/2 inch) below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph SLUMP, and set an upper action limit line and lower action limit line at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. Plot the range between each consecutive slump test for each type of mixture on a single control chart for range on which an upper action limit is set at 50 mm (2 inches). Take samples for slump at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the materials or transportation methods cause slump loss between mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the slump at the mixer as directed.

3.4.2.6.4 Slump Corrective Action

Whenever points on the control chart for slump reach the upper warning limit, immediately adjust the batch weights of water and fine aggregate. Make adjustments so that the total water content does not exceed that amount allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, no further concrete may be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, immediately halt the concreting operation and take appropriate steps to bring the slump under control. Also, make additional slump tests as directed.

3.4.2.6.5 Temperature

Measure the temperature of the concrete when compressive strength specimens are fabricated. Measure in accordance with ASTM C1064/C1064M. Report the temperature along with the compressive strength data.

3.4.2.6.6 Compressive-Strength Specimens

Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M. Make six test cylinders. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 77 cubic meters (100 cubic yards) of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Prepare concrete test specimens in accordance with ASTM C31/C31M. Perform compressive strength testing in accordance with ASTM C39/C39M.

3.4.2.7 Inspection Before Placing

Inspect foundation or construction joints, forms, and embedded items for quality in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. Report the results of each inspection in writing.

3.4.2.8 Placing

3.4.2.8.1 Placing Inspection

The placing foreman supervises all placing operations, determines that the correct quality of concrete or grout is placed in each location as directed and is for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.

3.4.2.8.2 Placing Corrective Action

The placing foreman must not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Discontinue placing if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, take immediate steps to improve temperature controls.

3.4.2.9 Vibrators

3.4.2.9.1 Vibrator Testing and Use

Determine the frequency and amplitude of each vibrator in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Make sdditional tests as directed when a vibrator does not appear to be adequately consolidating the concrete. Determine the frequency at the same time the vibrator is operating in concrete with the tachometer held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. Determine the amplitude with the head vibrating in air. Take two measurements, one near the tip and another near the upper end of the vibrator head and average these results. Report the make, model, type, and size of the vibrator and frequency and amplitude results in writing.

3.4.2.9.2 Vibrator Corrective Action

Immediately remove any vibrator not meeting the requirements of paragraph VIBRATORS from service and repair or replace.

3.4.2.10 Mixer Uniformity

Submit the results of the initial mixer uniformity tests, at least 5 days prior to the initiation of placing.

3.4.2.10.1 Stationary Mixers

Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 57,000 cubic meters (75,000 cubic yards) of concrete placed, whichever results in the longest time interval, determine uniformity of concrete mixing in accordance with ASTM C94/C94M.

3.4.2.10.2 Truck Mixers

Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete in accordance with ASTM C94/C94M. Randomly select the truck mixers for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.4.2.11 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either remove the mixer from service on the work, increase the mixing time, change the batching sequence, reduce the batch size, or adjust the mixer until compliance is achieved.

3.4.3 Reports

Report all results of tests or inspections conducted informally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make reports of pertinent temperatures daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all test and inspection records.

-- End of Section --

SECTION 03 35 00.00 10

CONCRETE FINISHING
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 301	(2010; ERTA 2015) Specifications for Structural Concrete
ACI 301M	(2010; ERTA 2015) Metric Specifications for Structural Concrete
ACI 303R	(2012) Guide to Cast-In-Place Architectural Concrete Practice
ACI 305R	(2010) Guide to Hot Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Recycled Content Products; (LEED)

SD-04 Samples

Field Test Panels
Sample Wall Panels
Slab Panels

SD-08 Manufacturer's Instructions

Dry Shake Finish

PART 2 PRODUCTS

In accordance with Section 01 33 29 SUSTAINABILITY REPORTING submit documentation indicating: distance between manufacturing facility and the project site, distance of raw material origin from the project site, percentage of post-industrial and post-consumer recycled content per unit of product and relative dollar value of recycled content products to total dollar value of products included in project. Provide submittals as specified in the subject Section.

PART 3 EXECUTION

3.1 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03 11 13.00 10 STRUCTURAL CAST-IN-PLACE CONCRETE FORMING. Finish formed surfaces as specified herein. Unless another type of architectural or special finish is specified, leave surfaces with the texture imparted by the forms except that defective surfaces must be repaired.

Maintain uniform color of the concrete by use of only one mixture without changes in materials or proportions for any structure or portion of structure. The form panels used to produce the finish must be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features. Do not reuse forms if there is any evidence of surface wear or defects that would impair the quality of the surface.

3.1.1 Class A Finish

Class A finish is required where indicated. Formed surfaces meet the requirements of ACI 301M (ACI 301), surface finish SF-3.0.

3.1.2 Class B Finish

Class B finish is required where indicated. Formed surfaces meet the requirements of ACI 301M (ACI 301), surface finish SF-2.0.

3.1.3 Class C and Class D Finish

Class C finish is required where indicated. Class D finish is required where indicated. Formed surfaces meet the requirements of ACI 301M (ACI 301), surface finish SF-1.0.

3.1.4 Architectural and Special Finishes

Architectural concrete finishes are specified in Section 03 33 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE. Conform special finishes to the requirements specified herein.

3.1.4.1 Smooth Finish

After other concrete construction is complete in each overall separate contiguous area of the structure, apply smooth finish to the areas indicated. Use a mortar mix consisting of one part portland cement and two parts well-graded sand passing a 0.6 mm (No. 30) sieve, with water added to give the consistency of thick paint. Where the finished surface will not receive other applied surface, use white cement to replace part of the job cement to produce an approved color, which must be uniform throughout the surfaces of the structure. After the surface has been thoroughly wetted and allowed to approach surface dryness, vigorously apply the mortar to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Scrape off excess grout with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, rub the area with burlap pads having on their surface the same sand-cement mix specified above but without any mixing water, until all of

the visible grout film is removed. Tightly stretch the burlap pads used for this operation around a board to prevent dishing the mortar in the voids. Complete the finish of any area in the same day, and make the limits of a finished area at natural breaks in the surface. Continuously moist cure the surface for 48 hours commencing immediately after finishing operations in each area. The temperature of the air adjacent to the surface must be not less than 10 degrees C (50 degrees F) for 24 hours prior to, and 48 hours after, the application. In hot, dry weather apply the smooth finish in shaded areas or at night, and never be apply when there is significant hot, dry wind.

3.1.4.2 Tooled Finish

Dress the thoroughly cured concrete at an approved age with approved electric, air, or hand tools to a uniform texture with a hand-tooledsurface texture.

3.2 REPAIRS

Repair in accordance with ACI 301M (ACI 301), Section 5.

3.3 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces must meet the requirements of paragraph TOLERANCES in Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE or CONSTRUCTION TOLERANCES in Section 03 31 01.00 10 STRUCTURAL CONCRETE FOR CIVIL WORKS, when tested as specified herein.

3.3.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed must not be less than 5 degrees C (40 degrees F). In hot weather meet all requirements of Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE paragraphs HOT WEATHER REQUIREMENTS and PREVENTION OF PLASTIC SHRINKAGE CRACKING. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 1.0 kg/square meter (0.2 pounds per square foot) per hour. Make provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement, and take such protective measures as quickly as finishing operations will allow. Float finish unformed surfaces that are not to be covered by additional concrete or backfill, with additional finishing as specified below, and true to the elevation indicated. Bring surfaces to receive additional concrete or backfill to the elevation indicated, properly consolidate, and leave true and regular. Unless otherwise indicated, evenly slope exterior surfaces for drainage. Where drains are provided, evenly slope interior floors to the drains. Carfully make joints with a jointing or edging tool. Protect the finished surfaces from stains or abrasions. Grate tampers or "jitterbugs" cannot be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing is not be permitted. If bleedwater is present prior to finishing, carefully drag off the excess water or remove by absorption with porous materials such as burlap. During finishing operations, take extreme care to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Remove and replace any slabs with surfaces which exhibit significant crazing. During finishing operations, check surfaces with a 3 m (10 foot) straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.3.2 Rough Slab Finish

In accordance with ACI 301M (ACI 301), Section 5.

3.3.3 Float Finish

In accordance with ACI 301M (ACI 301), Section 5.

3.3.4 Trowel Finish

In accordance with ACI 301M (ACI 301), Section 5.

3.3.5 Non-Slip Finish

Construct non-slip floors in accordance with ACI 301M (ACI 301), Section 5..

3.5 EXTERIOR SLAB AND RELATED ITEMS

3.5.1 Pavements

Immediately following the final consolidation of the surface, float the pavement longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, place and screed additional concrete, and operate the float until a satisfactory surface has been produced. Advance the floating operation not more than half the length of the float and then continued over the new and previously floated surfaces. After finishing is completed but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface by means of long-handled cutting straightedges. Use straightedges that are 3.75 m (12 feet) in length and operated from the sides of the pavement and from bridges. Equip a straightedge operated from the side of the pavement with a handle 1 m (3 feet) longer than one-half the width of the pavement. Test the surface for trueness with a 3.75 (12 foot) straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one-half the length of the straightedge. Immediately fill depressions with freshly mixed concrete, strike off, consolidate, and refinish. Also strice and refinish projections above the required elevation. Continue the straightedge testing and finishing until the entire surface of the concrete is true. Before the surface sheen has disappeared and well before the concrete becomes nonplastic, give the surface of the pavement a nonslip sandy surface texture by [belting with approved "belt" and procedures] [use of a burlap drag. A strip of clean, wet burlap from 1.0 to 1.5 m (3 to 5 feet) wide and 0.7 m (2 feet) longer than the pavement width shall be carefully pulled across the surface]. Round edges and joints with an edger having a radius of 3 mm (1/8 inch).

3.5.2 Sidewalks

Apply a lightly broomed finish.

3.5.3 Curbs and Gutters

Finish exposed surfaces using a stiff bristled brush.

-- End of Section --

SECTION 03 39 00

CONCRETE CURING
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 301	(2010; ERTA 2015) Specifications for Structural Concrete
ACI 301M	(2010; ERTA 2015) Metric Specifications for Structural Concrete
ACI 308.1	(2011) Specification for Curing Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials

SD-06 Test Reports

Testing and Inspection for CQC

SD-08 Manufacturer's Instructions

Curing Compound

1.3 DELIVERY, STORAGE, AND HANDLING

Store materials in such a manner as to avoid contamination and deterioration. Materials must be capable of being accurately identified after bundles or containers are opened.

PART 2 PRODUCTS

2.1 CURING MATERIALS

Provide curing materials in accordance with ACI 301M (ACI 301) Sections 5 and ACI 308.1 Section 2. Submit product data and manufacturer's instructions for concrete curing compound.

2.2 WATER

Provide water for curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of ASTM C1602/C1602M.

PART 3 EXECUTION

3.1 CURING AND PROTECTION

Cure and protect concrete in accordance with ACI 301M (ACI 301) Section 5.

3.2 TESTING AND INSPECTION FOR CQC

Perform the inspection and tests described below and, based upon the results of these inspections and tests, take the action required. Submit certified copies of laboratory test reports, including curing compound proposed for use on this project.

3.2.1 Moist Curing Inspections

At least once each shift, and not less than twice per day on both work and non-work days, inspect all areas subject to moist curing. Note and record the surface moisture condition.

3.2.2 Moist Curing Corrective Action

When a daily inspection report lists an area of inadequate curing, take immediate corrective action, and extend the required curing period for those areas by 1 day.

3.2.3 Membrane Curing Inspection

Apply no curing compound until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, compute the rate of coverage in square meters/L (square feet/gallon), and note whether or not coverage is uniform.

3.2.4 Membrane Curing Corrective Action

When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, spray the entire surface again.

3.2.5 Sheet Curing Inspection

At least once each shift and once per day on non-work days, inspect all areas being cured using impervious sheets. Note and record the condition of the covering and the tightness of the laps and tapes.

3.2.6 Sheet Curing Corrective Action

When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, promptly repair the tears and holes or replace the sheets, close the joints, and extend the required curing period for those areas by 1 day.

-- End of Section --

SECTION 03 62 16

METALLIC NON-SHRINK GROUTING
05/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.5R	(2014) Guide for Submittal of Concrete Proportions
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 311.4R	(2005) Guide for Concrete Inspection
ACI MCP SET	(2016) Manual of Concrete Practice

ASTM INTERNATIONAL (ASTM)

ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C150/C150M	(2016) Standard Specification for Portland Cement
ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Grout Placement and Inspection Reports; G

SD-04 Samples

Aggregates; G

Expansive Admixtures; G

SD-06 Test Reports

Expansion; G

Compressive Strength; G

Grout Placement and Inspection Reports; G

Expansive Grout; G

Portland Cement; G

SD-07 Certificates

Portland Cement; G

Expansive Admixtures; G

Expansive Grout; G

Aggregates; G

1.3 QUALITY CONTROL

1.3.1 Grout Placement Plan and Inspection Reports

Provide examples of grout placement and inspection reports in accordance with ACI 214R, ACI 211.5R, ACI 311.4R and ACI MCP SET. Show details of proposed methods of application, with written instructions from the manufacturer for the use of expansive admixture at least 45calendar days prior to the start of expansive concrete operations.

Include a copy of records of inspections and tests as well as the records of corrective action taken. Include descriptions of preparation of cavities for placement of grout; proper mixing, placement, and curing of grout with methods of preventing discoloration.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Portland Cement

Provide portland cement grout conforming to ASTM C150/C150M for Cement, Type I.

2.1.2 Aggregates

Submit samples conforming to ASTM C33/C33M for aggregates and the gradation as directed.

2.1.3 Water

Provide potable water.

2.1.4 Expansive Admixtures

Submit samples to the Contracting Officer prior to commencement of work for review and acceptance.

2.1.5 Expansive Grout

Provide Type A grout containing an oxidizable metallic aggregate and an oxidation-promoting ingredient. Conform to the manufacturer's printed instructions.

Provide Type B grout containing a metallic aluminum powder with alkali hydroxides in solution. Do not exceed 1 teaspoon per bag of cement for the quantity of aluminum powder.

PART 3 EXECUTION

3.1 PREPARATION

Prepare cavities for grouting by cleaning away foreign matter, laitance, dirt, grease or oil. Clean all contact surfaces of concrete and masonry no less than 24 hours before grout application.

3.1.1 Mixing

Mix grout ingredients for both cementitious grout and epoxy grout in accordance with the manufacturer's written mixing instructions and recommendations.

Mix grout materials in proper mechanical mixers.

Mix grout as close to work area as possible.

3.2 APPLICATION

3.2.1 Placing Grout

Place grout in accordance with the manufacturer's written installation instructions and recommendations. Do not use grout which has begun to set or if more than one hour has elapsed after initial mixing.

Fill blind cavities by pressure injection under controlled venting. Start injection and continue with the vent open until waste grout is expelled through vent with the same consistency, then block the vent for pressurization to 413 kilopascal (60 psi). Use lower pressures when damage to construction may result.

3.3 FIELD QUALITY CONTROL

Provide testing and submit test reports in accordance with ASTM C1107/C1107M for the expansive grout to meet the following performance requirements:

Expansion: 28 calendar days - Percent maximum: 0.3

- Percent minimum: 0.0

Compressive Strength: 34 Megapascal (5,000 psi)

3.4 PROTECTION

Protect freshly placed grout from premature drying and excessive cold or hot temperatures. Comply with manufacturer's requirements for cold-weather and hot-weather protection during curing.

-- End of Section --

GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ACI INTERNATIONAL (ACI)

a.	ACI 318	Building Code Requirements for Structural Concrete and Commentary
b.	ACI 530	Building Code Requirements for Masonry Structures Commentaries
c.	ACI 530.1	Specification for Masonry Structures
d.	ACI SP-66	ACI Detailing Manual

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
b.	ASTM A 167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
c.	ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
d.	ASTM A 641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
e.	ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
f.	ASTM B 370	Standard Specification for Copper Sheet and Strip for Building Construction
g.	ASTM C 1019	Standard Test Method for Sampling and Testing Grout
h.	ASTM C 1072	Standard Test Method for Measurement of Masonry Flexural Bond Strength
i.	ASTM C 1142	Standard Specification for Extended Life Mortar for Unit Masonry
j.	ASTM C 1289	Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
k.	ASTM C 129	Standard Specification for Nonloadbearing Concrete Masonry Units
l.	ASTM C 140	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
m.	ASTM C 144	Standard Specification for Aggregate for Masonry Mortar

n.	ASTM C 150	Standard Specification for Portland Cement
o.	ASTM C 207	Standard Specification for Hydrated Lime for Masonry Purposes
p.	ASTM C 216	Facing Brick (Solid Masonry Units Made from Clay or Shale)
q.	ASTM C 27	Fireclay and High-Alumina Refractory Brick
r.	ASTM C 270	Standard Specification for Mortar for Unit Masonry
s.	ASTM C 315	Clay Flue Linings
t.	ASTM C 476	Standard Specification for Grout for Masonry
u.	ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
v.	ASTM C 55	Concrete Brick
w.	ASTM C 578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
x.	ASTM C 593	Fly Ash and Other Pozzolans for Use with Lime
y.	ASTM C 62	Building Brick (Solid Masonry Units Made from Clay or Shale)
z.	ASTM C 641	Staining Materials in Lightweight Concrete Aggregates
aa.	ASTM C 652	Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
bb.	ASTM C 67	Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
cc.	ASTM C 744	Prefaced Concrete and Calcium Silicate Masonry Units
dd.	ASTM C 780	Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ee.	ASTM C 90	Loadbearing Concrete Masonry Units
ff.	ASTM C 91	Masonry Cement
gg.	ASTM C 94	Standard Specification for Ready-Mixed Concrete
hh.	ASTM C 989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ii.	ASTM D 2000	Standard Classification System for Rubber Products in Automotive Applications
jj.	ASTM D 2240	Standard Test Method for Rubber Property - Durometer Hardness
kk.	ASTM D 2287	Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ll.	ASTM E 119	Standard Test Methods for Fire Tests of Building Construction and Materials
mm.	ASTM E 514	Water Penetration and Leakage Through Masonry

1.1.1.3 INTERNATIONAL CODE COUNCIL (ICC)

a.	ICC IBC	International Building Code

1.1.1.4 U.S. DEPARTMENT OF DEFENSE (DOD)

a. UFC 3-310-04 Seismic Design for Buildings

1.1.1.5 U.S. GREEN BUILDING COUNCIL (USGBC)

a. LEED Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Structural Masonry

(1) Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings. Bar splice locations shall be shown. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1/4 inch per foot. Reinforcement bending details shall conform to the requirements of ACI SP-66.

1.2.1.2 SD-03 Product Data

a. Local/Regional Materials; (LEED)

(1) Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

b. Environmental Data

c. Clay Brick (LEED)

d. Concrete Brick

e. Concrete Masonry Units (CMU) (LEED)

f. Cement (LEED)

g. Insulation

h. Flashing

i. Water-Repellant Admixture

(1) Manufacturer's descriptive data. Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

j. Cold Weather Installation

(1) Cold weather construction procedures.

1.2.1.3 SD-04 Samples

a. Concrete Masonry Units

b. Concrete Brick

c. Stone Items

d. Clay Brick

(1) Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture. Submit sample of colored mortar with applicable masonry unit.

(2) Brick shall be Dyess Blend to match existing.

e. Anchors, Ties, and Bar Positioners

(1) Two of each type used.

f. Expansion-Joint Materials

(1) One piece of each type used.

g. Joint Reinforcement

(1) One piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

h. Insulation

(1) One piece of board type insulation, not less than 16 by 24 inches in size, containing the label indicating the rated permeance and R-values.

i. Portable Panel

(1) One panel of clay brick, 2 by 2 feet, containing approximately 24 brick facings to establish range of color and texture.

1.2.1.4 SD-05 Design Data

a. Pre-mixed Mortar

b. Unit Strength Method

(1) Pre-mixed mortar composition. Calculations and certifications of masonry unit and mortar strength.

1.2.1.5 SD-06 Test Reports

a. Efflorescence Test

b. Field Testing of Mortar

c. Field Testing of Grout

d. Prism tests

e. Masonry Cement

f. Fire-rated CMU

(1) Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

g. Special Inspection

(1) Copies of masonry inspector reports.

1.2.1.6 SD-07 Certificates

a. Clay Brick

b. Concrete Brick

c. Concrete Masonry Units (CMU)

d. Control Joint Keys

e. Anchors, Ties, and Bar Positioners

f. Expansion-Joint Materials

g. Joint Reinforcement

h. Reinforcing Steel Bars and Rods

i. Masonry Cement

j. Mortar Coloring

k. Insulation

l. Precast Concrete Items

m. Admixtures for Masonry Mortar

n. Admixtures for Grout

(1) Certificates of compliance stating that the materials meet the specified requirements.

o. Insulation

(1) Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

1.2.1.7 SD-08 Manufacturer's Instructions

a. Masonry Cement

(1) When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required.

1.2.1.8 SD-10 Operation and Maintenance Data

a. Take-Back Program

(1) Documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.3 SAMPLE MASONRY PANELS

1.3.1 After material samples are approved and prior to starting masonry work, a portable panel of

clay brick and sample masonry panels shall be constructed for each type and color of masonry required. At least 48 hours prior to constructing the sample panel or panels, the Contractor shall submit written notification to the Contracting Officer's Representative. Sample panels shall not be built in, or as part of the structure, but shall be located where directed.

1.3.1.1 Configuration

a. Panels shall be L-shaped or otherwise configured to represent all of the wall elements. Panels shall be of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. The minimum size of a straight panel or a leg of an L-shaped panel shall be 8 feet long by 4 feet high.

1.3.1.2 Composition

a. Panels shall show full color range, texture, and bond pattern of the masonry work. The Contractor's method for mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work shall be demonstrated during the construction of the panels. Installation or application procedures for anchors, wall ties, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, row lock courses and weep holes shall be shown in the sample panels. The panels shall contain a corner that includes a bond beam corner. Panels that represent reinforced masonry shall contain a 2 by 2 foot opening placed at least 2 feet above the panel base and 2 feet away from all free edges, corners, and control joints. Required reinforcing shall be provided around this opening as well as at wall corners and control joints.

1.3.1.3 Construction Method

a. Where anchored veneer walls are required, the Contractor shall demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Temporary provisions shall be demonstrated to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on the drawings. Where masonry is to be grouted, the Contractor shall demonstrate and receive approval on the method that will be used to bring up the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. If sealer is specified to be applied to the masonry units, sealer shall be applied to the sample panels. Panels shall be built on a concrete foundation.

1.3.1.4 Usage

a. The completed panels shall be used as the standard of workmanship for the type of masonry represented. Masonry work shall not commence until the sample panel for that type of masonry construction has been completed and approved. Panels shall be protected from the weather and construction operations until the masonry work has been completed and approved. After completion of the work, the sample panels, including all foundation concrete, shall become the property of the Contractor and shall be removed from the construction site.

1.4 DELIVERY, HANDLING, AND STORAGE

1.4.1 Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.4.1.1 Masonry Units

a. Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C 90. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.1.2 Reinforcement, Anchors, and Ties

a. Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.4.1.3 Cementitious Materials, Sand and Aggregates

a. Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.5 STRUCTURAL MASONRY

1.5.1 Special Inspection

1.5.1.1 A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

1.5.2 Unit Strength Method

1.5.2.1 Compute compressive strength of masonry system "Unit Strength Method," ACI 530. Submit calculations and certifications of unit and mortar strength.

1.5.3 Seismic Requirement

1.5.3.1 In addition to design requirements of ICC IBC, the Contractor shall provide additional seismic reinforcement in accordance with UFC 3-310-04.

1.6 QUALITY ASSURANCE

1.6.1 Appearance

1.6.1.1 Blend all brick to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable.

1.6.2 Testing

1.6.2.1 Masonry strength shall be determined in accordance with ACI 530; submit test reports on three prisms as specified in ACI 530.1. The cost of testing shall be paid by the Contractor.

1.6.3 Spare Vibrator

1.6.3.1 Maintain at least one spare vibrator on site at all times.

1.6.4 Bracing and Scaffolding

1.6.4.1 Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

1.7 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

1.7.1.1 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

2.2 CLAY BRICK

2.2.1 Color range and texture of clay brick shall be as indicated and shall conform to the approved sample. Brick shall conform to ASTM C 62; Grade SW shall be used for brick in contact with earth or grade and for all exterior work and for all nonvertical surfaces. Grade SW or MW shall be used in other brickwork. Average dimensions of brick shall be 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long (standard) or 4 inches thick, 2-2/3 inches high, and 8 inches long (nominal)), subject to the tolerances specified in ASTM C 62. Brick shall be tested for efflorescence. Clay brick units shall be delivered factory-blended to provide a uniform appearance and color range in the completed wall. Clay brick units may contain post-consumer or post-industrial recycled content.

2.2.1.1 Solid Clay Brick

a. Solid clay brick shall conform to ASTM C 216, Type FBS or FBX as indicated. Brick size shall be modular and the nominal size of the brick used shall be 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long (nominal) or 4 inches thick, 2-2/3 inches high and 8 inches long (nominal).

2.2.1.2 Hollow Clay Brick

a. Hollow clay brick shall conform to ASTM C 652, Type HBS or HBX. Brick size shall be modular and the nominal size of the brick used shall be 2-1/4 inches thick, 2-1/4 inches high,

and 8 inches long (nominal). Where vertical reinforcement is shown in hollow brick, the minimum cell dimension shall be 2-1/2 inches and the units shall be designed to provide precise vertical alignment of the cells.

2.2.1.3 Refractory Brick

a. ASTM C 27, low-duty type.

2.2.1.4 Closure or Utility Brick

a. ASTM C 216, Grade SW, Type FBS, 3-5/8 inches thick, 3-5/8 inches high, and 8 inches long (closure) or 4 inches thick, 4 inches high, and 12 inches long (utility). Closure or Utility brick shall be used where required to match existing. Color, texture, and range of brick shall match the existing brick on the Building.

2.3 CONCRETE BRICK

2.3.1 Concrete brick shall conform to ASTM C 55. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

2.4 SALVAGED BRICK

2.4.1 Use salvaged bricks and other masonry units in place of new bricks or masonry units as indicated. When using salvaged brick, select exterior face bricks from salvaged exterior face bricks. Bricks shall meet standards of new bricks otherwise used in application, and shall be cleaned of all mortar prior to use. Place exterior face towards the exterior.

2.4.2 Provide Grace Products: Dry-Block II mortar admixture, or equal, to all exterior mortar per manufactures recommendations.

2.5 CONCRETE MASONRY UNITS (CMU)

2.5.1 Cement shall have a low alkali content and be of one brand. Units may contain post-consumer or post-industrial recycled content. Units shall be of modular dimensions and air, water, or steam cured. Exposed surfaces of units shall be smooth and of uniform texture. Exterior concrete masonry units shall have water-repellant admixture added during manufacture.

2.5.1.1 Hollow Load-Bearing Units

a. ASTM C 90, made with normal weight aggregate unless noted otherwise. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

2.5.1.2 Hollow Non-Load-Bearing Units

a. ASTM C 129, made with lightweight or normal weight aggregate as indicated. Load-bearing units may be provided in lieu of non-load-bearing units.

2.5.1.3 Solid Load-Bearing Units

a. ASTM C 90, normal weight units unless noted otherwise.

2.5.2 Aggregates

2.5.2.1 Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C 989.

2.5.3 Kinds and Shapes

2.5.3.1 Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

a. Architectural Units

(1) Units shall have patterned face shell. Face shell pattern shall be fluted, vertical scored, split ribbed or other pattern as required by the TO SOW. Units shall be integrally colored during manufacture if indicated. Patterned face shell shall be properly aligned in the completed wall.

b. Patterned, Decorative Screen Units

(1) Patterned, decorative screen units shall conform to the applicable requirements of ASTM C 90. Units shall have uniform through-the-wall pattern, color, and texture.

2.5.4 Fire-Rated CMU

2.5.4.1 Concrete masonry units used in fire-rated construction shown on the drawings shall be of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated on the aggregate requiring the greater minimum equivalent thickness to produce the required fire rating. Construction shall conform to ASTM E 119.

a. TABLE I

FIRE-RATED CONCRETE MASONRY UNITS

See note (a) below

	Minimum equivalent thickness inches for fire rating of:		
Aggregate Type	4 hours	3 hours	2 hours
Pumice	4.7	4.0	3.0
Expanded Slag	5.0	4.2	3.3
Expanded clay, shale, or slate	5.7	4.8	3.7

Limestone, scoria, cinders or unexpanded slag	5.9	5.0	4.0
Calcareous gravel	6.2	5.3	4.2
Siliceous gravel	6.7	5.7	4.5

a. Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C 140 divided by the product of the actual length and height of the face shell of the unit in inches. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; the thickness of plaster or brick or other material in the assembly will be included in determining the equivalent thickness.

2.6 PRECAST CONCRETE ITEMS

2.6.1 Trim, lintels, copings, splashblocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 4,000 psi minimum conforming to Section 03 30 00 Cast-In-Place Concrete using 1/2 inch to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 3/4 inch shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 120 psi for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

2.6.1.1 Lintels

a. Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 4 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure. In reinforced masonry, lintels shall conform to ACI 318 for flexural and shear strength and shall have at least 8 inches bearing at each end. Concrete shall have a minimum 28 day compressive strength of 4,000 psi using 1/2 inch to No. 4 nominal-size coarse aggregate. Reinforcement shall conform to ASTM A 615 Grade 60,000 psi. Limit lintel deflection due to dead plus live

load to L/600 or 0.3 inches. Provide top and bottom bars for lintels over 36 inches in length.

2.6.1.2 Sills and Copings

a. Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 1/4 inch allowance for mortar joints. The ends of sills, except a 3/4 inch wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings. Reinforce sills with not less than two No. 4 bars.

2.6.1.3 Splash Blocks

a. Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.6.1.4 Flue Linings and Thimbles

a. ASTM C 315, free from fractures. Sizes and shapes shall be as indicated.

2.7 STONE ITEMS

2.7.1 Stone for trim, sills, lintels, and copings shall be limestone, sandstone, or granite as indicated, and shall be cut to the design shown. Sandstone shall be standard grade, buff, gray, or buff brown, with a smooth finish free from clay pits and tool marks. Granite shall be a good commercial grade building granite of medium or moderately coarse grain, and a light or medium gray or light pink color, with a smooth machine finish on washes, 4-cut finish on treads, and 6-cut or equivalent machine finish on other exposed surfaces. Limestone shall be standard buff limestone with a smooth machine finish free from tool marks. Lintels, except when supported by a steel member, shall be 4 inches or more thick from face to back edge and of the depth required to support the masonry over the opening. Stone shall have beds and joints at right angles to the face, with sharp, true arises. Copings and sills shall be provided with washes, and where overhanging the walls, shall have drips cut on the underside.

2.8 MORTAR FOR STRUCTURAL MASONRY

2.8.1 ASTM C 270, Type S. Strength (f'm) as indicated. Test in accordance with ASTM C 780. Use Type II portland cement. Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar. Use up to 40 percent Class F fly ash with type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C 593.

2.9 MASONRY MORTAR

2.9.1 Mortar Type S or N shall conform to the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; Type N cement-lime mortar proportions shall be 1 part cement, 1 part lime and 6 parts aggregate. Type N or S mortar shall be used for non-load-bearing, non-shear-wall interior masonry; approved commercial fire clay mortar or refractory cement (calcium-aluminate) mortar for fire brick and flue liners; and Type S for remaining masonry work; except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in

an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.9.1.1 Admixtures for Masonry Mortar

a. In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

2.9.1.2 Colored Mortar

a. Mortar coloring shall be added to the mortar used for exposed masonry surfaces as indicated to produce a uniform color matching sample identified by C.O. Mortar coloring shall be chemically inert, of finely ground limeproof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement.

b. Standard Face: Featherlite “Western Tan” with Amerimix-32x-Golden Brown Mortar

2.9.1.3 Hydrated Lime and Alternates

a. Hydrated lime shall conform to ASTM C 207. Lime alternates which have a current ICBO, ICBO UBC, Evaluation Report number whose findings state it may be used as an alternate to lime for Type S, N, and O mortars will be deemed acceptable provided the user follows the manufacturer's proportions and mixing instructions as set forth in ICBO report.

2.9.1.4 Cement

a. Portland cement shall conform to ASTM C 150, Type II. Masonry cement shall conform to ASTM C 91, Type N or S. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. Additives shall conform to requirements in Section 03 30 00 Cast-In-Place Concrete.

2.9.1.5 Pre-Mixed Mortar

a. Pre-mixed mortar shall conform to ASTM C 1142, Type RN or RS.

2.9.1.6 Sand and Water

a. Sand shall conform to ASTM C 144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.10 WATER-REPELLANT ADMIXTURE

2.10.1 Polymeric type formulated to reduce porosity and water transmission. Construct panels of masonry units conforming to ASTM C 744 and mortar which contain the water-repellant admixture. When tested in accordance with ASTM C 1072, such panels shall have flexural strength not less than that specified or indicated. When tested in accordance with ASTM E 514, panels shall exhibit no water visible on back of test panel and no leaks through the panel after 24 hours, and not more than 25 percent of wall area shall be damp after 72 hours.

2.10.2 Provide Grace Dry-Block II mortar admixture (or equal) to ALL exterior mortar.

2.11 GROUT AND READY-MIXED GROUT

2.11.1 Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content.

Grout slump shall be between 8 and 10 inches. Minimum grout strength shall be 2000 psi in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94.

2.11.1.1 Admixtures for Grout

a. In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

2.11.1.2 Grout Barriers

a. Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

b. Provide continuous Mortar Net or similar grout barrier at bottoms of ALL exterior walls.

2.12 ANCHORS, TIES, AND BAR POSITIONERS

2.12.1 Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82. Wire ties or anchors in exterior walls shall conform to ASTM A 641. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A 641; coordinate with paragraph Joint Reinforcement below. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

2.12.1.1 Wire Mesh Ties

a. Wire mesh for tying 4 inch thick concrete masonry unit partitions to other intersecting masonry partitions shall be 1/2 inch mesh of minimum 16 gauge steel wire. Minimum lengths shall be not less than 12 inches.

2.12.1.2 Wall Ties

a. Wall ties shall be rectangular-shaped or Z-shaped fabricated of 3/16 inch diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 4 inches wide. Wall ties may also be of a continuous type conforming to paragraph Joint Reinforcement. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 3/16 inch diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 1/2 inch eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 1/16 inch. The pintle and eye elements shall be formed so that both can be in the same plane.

2.12.1.3 Dovetail Anchors

a. Dovetail anchors shall be of the flexible wire type, 3/16 inch diameter zinc-coated steel wire, triangular shaped, and attached to a 12 gauge or heavier steel dovetail section. These anchors shall be used for anchorage of veneer wythes or composite-wall facings extending over the face of concrete columns, beams, or walls. Cells within vertical planes of these anchors shall be filled solid with grout for full height of walls or partitions, or solid units may be used.

2.12.1.4 Adjustable Anchors

a. Adjustable anchors shall be 3/16 inch diameter steel wire, triangular-shaped. Anchors attached to steel shall be 5/16 inch diameter steel bars placed to provide 1/16 inch play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

2.12.1.5 Bar Positioners

a. Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.13 JOINT REINFORCEMENT

2.13.1 Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features.

2.14 REINFORCING STEEL BARS AND RODS

2.14.1 Reinforcing steel bars and rods shall conform to ASTM A 615, Grade 60.

2.15 CONTROL JOINT KEYS

2.15.1 Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000 or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 5/8 inch thick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 30 degrees F after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.16 INSULATION

2.16.1 Rigid Board-Type Insulation

2.16.1.1 Rigid board-type insulation shall be extruded polystyrene, polyurethane, or polyisocyanurate. Polystyrene shall conform to ASTM C 578. Polyisocyanurate shall conform to ASTM C 1289, Type I, Class 1 or 2, faced with aluminum foil on both sides of the foam. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

a. Aged R-Value

(1) The insulation shall provide a minimum aged R-value as indicated. The aged R-value shall be determined at 75 degrees F in accordance with the appropriate referenced specification. The stated R-value of the insulation shall be certified by an independent testing laboratory or certified by an independent Registered Professional Engineer if tests are conducted in the manufacturer's laboratory.

2.16.2 Insulation Adhesive

2.16.2.1 Insulation adhesive shall be specifically prepared to adhere the insulation to the masonry and, where applicable, to the thru-wall flashing. The adhesive shall not deleteriously affect the insulation, and shall have a record of satisfactory and proven performance for the conditions under which to be used.

2.17 EXPANSION-JOINT MATERIALS

2.17.1 Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07 92 00 Joint Sealants, and shall be penetrating.

2.17.2 Masonry Control Joint Sealant: TAN, Stampeade 1- polyurethane Sealant by Sherwin Williams

2.18 FLASHING

2.18.1 Flashing shall be as specified in Section 07 60 00 Flashing And Sheet Metal. Provide one of the following types:

2.18.1.1 Coated-Copper Flashing: 7 ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, elastic bituminous compound. Factory apply coating to a weight of not less than 6 ounces/square on each side.

2.18.1.2 Copper or Stainless Steel Flashing: Copper, ASTM B 370, minimum 16 ounce weight; stainless steel, ASTM A 167, Type 301, 302, 304, or 316, 0.015 inch thick, No. 2D finish. Provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions. Deformations shall consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.

2.18.1.3 ~~Reinforced~~ Membrane Flashing: Polyester film core with a reinforcing fiberglass scrim ~~bonded~~ to one side. ~~The membrane~~ shall be impervious to moisture, ~~flexible, and~~ not affected by caustic alkalis. The material, ~~after being exposed for not less than~~ 1/2 hour to a temperature of 32 degrees F, shall show no cracking ~~when~~, at that ~~temperature~~, it is bent 180 degrees over a 1/16 inch diameter ~~mandrel~~ and then bent at the same point over the ~~same size~~ mandrel in the ~~opposite~~ direction 360 degrees. Use reinforced membrane flashing in unexposed areas ~~only.~~

2.19 WEEP HOLE VENTILATORS

2.19.1 Weephole ventilators shall be prefabricated aluminum, plastic or sized to form the proper size opening in head joints. Provide aluminum and plastic inserts with grill or screen-type openings designed to allow the passage of moisture from cavities and to prevent the entrance or insects. Ventilators shall be sized to match modular construction with a standard 3/8 inch mortar joint.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.1.2 Hot Weather Installation

3.1.2.1 The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 90 degrees F and the wind velocity is more than 8 mph. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.3 Cold Weather Installation

3.1.3.1 Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F or temperature of masonry units is below 40 degrees F, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection. Conform to ACI 530.1 for hot and cold weather masonry erection.

a. Protection

(1) Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

(a) Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F.

(b) Air Temperature 32 to 25 Degrees F. Sand and mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing.

(c) Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.

(d) Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

b. Completed Masonry and Masonry Not Being Worked On

(1) Mean daily air temperature 40 to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

(2) Mean daily air temperature 32 to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

(3) Mean Daily Air Temperature minus 25 to 20 degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

(4) Mean Daily Temperature 20 degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.4 Stains

3.1.4.1 Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.1.5 Loads

3.1.5.1 Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.1.6 Surfaces

3.1.6.1 Surfaces on which masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

3.2.1 Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in the indicated bond pattern. Facing courses shall be level with back-up courses. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control,

expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 8 inches.

3.2.2 Forms and Shores

3.2.2.1 Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.3 Reinforced Concrete Masonry Units Walls

3.2.3.1 Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.2.4 Concrete Masonry Units

3.2.4.1 Units in piers, pilasters, columns, starting courses on footings, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.5 Clay Brick Units

3.2.5.1 Brick facing shall be laid with the better face exposed. Brick shall be laid in running bond with each course bonded at corners, unless otherwise indicated. Molded brick shall be laid with the frog side down. Brick that is cored, recessed, or has other deformations may be used in sills, treads, soldier courses, except where deformations will be exposed to view.

3.2.5.2 Wetting of Units

a. Wetting of clay brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface shall be in conformance with ASTM C 67. The

method of wetting shall ensure that each unit is nearly saturated but surface dry when laid. Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.2.5.3 Solid Units

a. Bed, head, and collar joints shall be completely filled with mortar.

3.2.5.4 Hollow Units

a. Hollow units shall be laid as specified for concrete masonry units.

3.2.5.5 Brick-Faced Walls

a. For brick-faced walls, bond brick in the pattern as indicated on the drawings. Provide additional bonding ties spaced not more than 3 feet apart around the perimeter of and within 12 inches of all openings.

(1) Collar Joints: Fill collar joints solid with mortar as each course of brick is laid. Do not disturb units in place.

(2) Brick Sills: Lay brick on edge, slope, and project not less than 1/2 inch beyond the face of the wall to form a wash and drip. Fill all joints solidly with mortar and tool.

3.2.5.6 Cavity Walls

a. Provide a continuous cavity as indicated. Securely tie the two wythes together with horizontal joint reinforcement. Bevel mortar beds away from cavity to prevent projection into cavity when bricks are shoved in place. Keep cavities clear and clean of mortar droppings. Provide weep holes of open head joints spaced 24 inches o.c.

3.2.5.7 Reinforced Brick Walls

a. Provide two wythes of brick separated by a continuous space filled with grout and reinforced as indicated. Bevel mortar beds away from grout space to prevent projection into grout space when bricks are shoved in place. Deeply furrowed bed joints will not be permitted. Lay exterior wythe of brick to the height of each grout pour in advance of interior wythe. Clean grout space and set reinforcing before laying interior wythe. Provide metal ties to prevent spreading of the wythes and to maintain vertical alignment of walls. Position reinforcing as indicated. Wire vertical reinforcing securely in position as the brickwork progresses. Use puddling rod or vibrator to consolidate the grout. The minimum clear distance between parallel bars shall be the nominal diameter of the bars; the minimum clear distance between masonry and reinforcing shall be 1/4 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together. Stagger splices in adjacent horizontal bars.

3.2.5.8 Brick Veneer

a. Provide a continuous cavity as indicated. Install brick veneer after sheathing, masonry anchors, and flashing have been installed to the cold-formed steel framing system. Care shall be provided to avoid damaging the moisture barrier. Damaged moisture barrier and flashing shall be repaired or replaced before brick veneer is installed. Means shall be provided to keep cavities clean and clear of mortar droppings.

3.2.6 Tolerances

3.2.6.1 Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

a. TABLE II

TOLERANCES

Variation from the plumb in the lines and surfaces of columns, walls and arises	
In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch
Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variation from level for bed joints and top surfaces of bearing walls	
In 10 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from horizontal lines	
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch

Variations in cross sectional dimensions of columns and in thickness of walls	
Minus	1/4 inch
Plus	1/2 inch

3.2.7 Cutting and Fitting

3.2.7.1 Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.8 Jointing

3.2.8.1 Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

a. Flush Joints

(1) Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

b. Tooled Joints

(1) Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

c. Door and Window Frame Joints

(1) On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.2.9 Joint Widths

3.2.9.1 Joint widths shall be as follows:

a. Concrete Masonry Units

(1) Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

b. Prefaced Concrete Masonry Units

(1) Prefaced concrete masonry units shall have a joint width of 3/8 inch wide on unfaced side and not less than 3/16 inch or more than 1/4 inch wide on prefaced side.

c. Brick

(1) Brick joint widths shall be the difference between the actual and nominal dimensions of the brick in either height or length. Brick expansion joint widths shall be as shown.

3.2.10 Embedded Items

3.2.10.1 Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.11 Unfinished Work

3.2.11.1 Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.12 Masonry Wall Intersections

3.2.12.1 Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.13 Partitions

3.2.13.1 Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls. Interior partitions having 4 inch nominal thick units shall be tied to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 4 inches thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 ANCHORED VENEER CONSTRUCTION

3.3.1 The inner and outer wythes shall be completely separated by a continuous airspace as shown

on the drawings. Both the inner and the outer wythes shall be laid up together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings. A coarse gravel or drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 4 inches of coarse aggregate or 10 inches of drainage material to keep mortar droppings from plugging the weep holes.

3.4 WEEP HOLES

3.4.1 Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated on drawings. Weep holes shall be clear round holes not less than 1/4 inch in diameter at 24 inches o.c. Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Weep holes shall be kept free of mortar and other obstructions.

3.5 COMPOSITE WALLS

3.5.1 Masonry wythes shall be tied together with joint reinforcement or with unit wall ties. Facing shall be anchored to concrete backing with wire dovetail anchors set in slots built in the face of the concrete. The facing wythe shall be anchored or tied to the backup at a maximum spacing of 16 inches on center vertically and 24 inches on center horizontally. Unit ties shall be spaced not over 24 inches on centers horizontally, in courses not over 16 inches apart vertically, staggered in alternate courses. Ties shall be laid not closer than 5/8 inch to either masonry face. Ties shall not extend through control joints. Collar joints between masonry facing and masonry backup shall be filled solidly with grout.

3.6 MORTAR

3.6.1 Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set shall be discarded.

3.7 REINFORCING STEEL

3.7.1 Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

3.7.2 Positioning Bars

3.7.2.1 Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.7.3 Splices

3.7.3.1 Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.8 JOINT REINFORCEMENT INSTALLATION

3.8.1 Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 inch cover to either face of the unit.

3.9 PLACING GROUT

3.9.1 Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.9.2 Vertical Grout Barriers for Fully Grouted Walls

3.9.2.1 Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.9.3 Horizontal Grout Barriers

3.9.3.1 Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.9.4 Grout Holes and Cleanouts

3.9.4.1 Grout Holes

a. Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 16 inches on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less

than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

3.9.4.2 Cleanouts for Hollow Unit Masonry Construction

a. Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 32 inches where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 3 by 4 inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.9.4.3 Cleanouts for Solid Unit Masonry Construction

a. Cleanouts for construction of walls consisting of a grout filled cavity between solid masonry wythes shall be provided at the bottom of every pour by omitting every other masonry unit from one wythe. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanout holes shall not be plugged until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.9.5 Grouting Equipment

3.9.5.1 Grout Pumps

a. Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.9.5.2 Vibrators

a. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.9.6 Grout Placement

3.9.6.1 Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of

grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

3.9.6.2 Low-Lift Method

a. Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

3.9.6.3 High-Lift Method

a. Mortar droppings shall be cleaned from the bottom of the grout space and from reinforcing steel. Mortar protruding more than 1/4 inch into the grout space shall be removed by dislodging the projections with a rod or stick as the work progresses. Reinforcing, bolts, and embedded connections shall be rigidly held in position before grouting is started. CMU units shall not be pre-wetted. Grout, from the mixer to the point of deposit in the grout space shall be placed as rapidly as practical by pumping and placing methods which will prevent segregation of the mix and cause a minimum of grout splatter on reinforcing and masonry surfaces not being immediately encased in the grout lift. The individual lifts of grout shall be limited to 4 feet in height. The first lift of grout shall be placed to a uniform height within the pour section and vibrated thoroughly to fill all voids. This first vibration shall follow immediately behind the pouring of the grout using an approved mechanical vibrator. After a waiting period sufficient to permit the grout to become plastic, but before it has taken any set, the succeeding lift shall be poured and vibrated 12 to 18 inches into the preceding lift. If the placing of the succeeding lift is going to be delayed beyond the period of workability of the preceding, each lift shall be reconsolidated by reworking with a second vibrator as soon as the grout has taken its settlement shrinkage. The waiting, pouring, and reconsolidation steps shall be repeated until the top of the pour is reached. The top lift shall be reconsolidated after the required waiting period. The high-lift grouting of any section of wall between vertical grout barriers shall be completed to the top of a pour in one working day unless a new series of cleanout holes is established and the resulting horizontal construction joint cleaned. High-lift grout shall be used subject to the limitations in Table III.

(1) TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (feet) (4)	Grout Type	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (in.) (1,2) Grouting Procedure	Multiwythe Masonry (3)	Hollow-unit Masonry
1	Fine	Low Lift	3/4	1-1/2 x 2
5	Fine	Low Lift	2	2 x 3

8	Fine	High Lift	2	2 x 3
12	Fine	High Lift	2-1/2	2-1/2 x 3
24	Fine	High Lift	3	3 x 3
1	Coarse	Low Lift	1-1/2	1-1/2 x 3
5	Coarse	Low Lift	2	2-1/2 x 3
8	Coarse	High Lift	2	3 x 3
12	Coarse	High Lift	2-1/2	3 x 3
24	Coarse	High Lift	3	3 x 4

Notes:
(1) The actual grout space or cell dimension must be larger than the sum of the following items:
  a) The required minimum dimensions of total clear areas given in the table above;
  b) The width of any mortar projections within the space;
  c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.
(2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 3/4 inch or greater in width.
(3) For grouting spaces between masonry wythes.
(4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.10 BOND BEAMS

3.10.1 Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

3.11 CONTROL JOINTS

3.11.1 Control joints shall be provided as indicated. Sash jamb units shall have a 3/4 by 3/4 inch groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 3/4 inch; backer rod and sealant shall be installed in accordance with Section 07 92 00 Joint Sealants. Exposed interior control joints shall be raked to a depth of 1/4 inch. Concealed control joints shall be flush cut.

3.12 BRICK EXPANSION JOINTS AND CONCRETE MASONRY VENEER JOINTS

3.12.1 Brick expansion joints and concrete masonry veneer joints shall be provided and constructed as shown on the drawings. Joints shall be kept free of mortar and other debris.

3.13 SHELF ANGLES

3.13.1 Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 10 feet and installed with a 1/4 inch gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 4 feet, unless limited by wall configuration.

3.14 LINTELS

3.14.1 Masonry Lintels

3.14.1.1 Masonry lintels shall be constructed with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

3.14.2 Precast Concrete and Steel Lintels

3.14.2.1 Precast concrete and steel lintels shall be as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

3.15 SILLS AND COPINGS

3.15.1 Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.16 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.16.1 Anchorage to Concrete

3.16.1.1 Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

3.16.2 Anchorage to Structural Steel

3.16.2.1 Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

3.17 INSULATION

3.17.1 Anchored veneer walls shall be insulated, where shown, by installing board-type insulation on the cavity side of the inner wythe. Board type insulation shall be applied directly to the masonry or thru-wall flashing with adhesive. Insulation shall be neatly fitted between obstructions without impaling of insulation on ties or anchors. The insulation shall be applied in parallel courses with vertical joints breaking midway over the course below and shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

3.18 SPLASH BLOCKS

3.18.1 Splash blocks shall be located as shown.

3.19 POINTING AND CLEANING

3.19.1 After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.19.2 Concrete Masonry Unit and Concrete Brick Surfaces

3.19.2.1 Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.19.3 Clay Brick Surfaces

3.19.3.1 Exposed clay brick masonry surfaces shall be cleaned as necessary to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, the sample panel of similar material shall be examined for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, the method of cleaning shall be changed to assure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 1/2 cup trisodium phosphate and 1/2 cup laundry detergent to one gallon of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

3.20 BEARING PLATES

3.20.1 Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03 30 00 Cast-In-Place Concrete.

3.21 PROTECTION

3.21.1 Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof

or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.22 WASTE MANAGEMENT

3.22.1 Manage waste according to the Waste Management Plan and as follows. Minimize water used to wash mixing equipment. Use trigger operated spray nozzles for water hoses.

3.22.2 Separate and Recycle Waste

3.22.2.1 Place materials defined as hazardous or toxic waste in designated containers. Fold up metal banding, flatten, and place in designated area for recycling. Collect wood packing shims and pallets and place in designated area.

3.22.3 Take-Back Program

3.22.3.1 Collect information from manufacturer for take-back program options. Set aside masonry units, full and partial to be returned to manufacturer for recycling into new product. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

3.23 TEST REPORTS

3.23.1 Field Testing of Mortar

3.23.1.1 At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.23.2 Field Testing of Grout

3.23.2.1 Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days.

3.23.3 Efflorescence Test

3.23.3.1 Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subject to rejection.

3.23.4 Prism Tests

3.23.4.1 At least one prism test sample shall be made for each 5,000 square feet of wall but not less than three such samples shall be made for any building. Three prisms shall be used in each sample. Prisms shall be tested in accordance with ACI 530.1. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than indicated on the structural drawings. If the compressive strength of any prism falls below the specified value by more than 500 psi, steps shall be taken to assure that the load-carrying capacity of the structure is not

jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 500 psi below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results shall be permitted.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

a.	AISC 360	Specification for Structural Steel Buildings, with Commentary

1.1.1.2 AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

a.	ASNT RP SNT-TC-1A	Recommended Practice

1.1.1.3 AMERICAN WELDING SOCIETY (AWS)

a.	AWS A2.4	Standard Symbols for Welding, Brazing and Nondestructive Examination
b.	AWS A3.0	Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting and Thermal Spraying
c.	AWS D1.1	Structural Welding Code - Steel
d.	AWS D1.3	Structural Welding Code - Sheet Steel
e.	AWS D1.4	Structural Welding Code - Reinforcing Steel
	AWS D14.1	Specification for Welding Industrial and Mill Cranes and Other Material Handling Equipment
f.	AWS D14.4	Specification for Welded Joints in Machinery and Equipment
g.	AWS Z49.1	Safety in Welding and Cutting and Allied Processes

1.1.1.4 ASTM INTERNATIONAL (ASTM)

a.	ASTM E 165	Standard Test Method for Liquid Penetrant Examination
b.	ASTM E 709	Standard Guide for Magnetic Particle Examination

1.2 DEFINITIONS

1.2.1 Definitions of welding terms are in accordance with AWS A3.0. The following classifications indicate the project's classes of weld joints.

1.2.1.1 Class 1 Weld Joints

a. This covers complete penetration weld joints only. These weld joints apply where failure would cause a loss of the system and/or be hazardous to personnel. Class 1 weld joints are highly stressed (dynamic and cyclic loading) and characterized as a single point of failure with no redundancy for the redistribution of stress into another member.

1.2.1.2 Class 2 Weld Joints

a. This covers both complete and partial penetration groove weld joints and fillet weld joints. These weld joints apply where failure would reduce the overall efficiency of a system but loss of the system or a hazard to personnel would not be experienced.

1.2.1.3 Class 3 Weld Joints

a. This covers both complete and partial penetration groove weld joints and fillet weld joints. These weld joints apply where failure would not affect the efficiency of a system nor create a hazard to personnel. Class 3 weld joints are connections of secondary members not subject to dynamic action and/or low stressed miscellaneous applications.

1.2.1.4 Class 4 Weld Joints

a. This covers weld joints applicable to welding reinforcing steel to primary structural members.

1.2.1.5 Class 5 Weld Joints

a. This covers weld joints applicable to welding concrete reinforcing steel splices (except prestressed steel), steel connection devices, and inserts and anchors required in concrete construction.

1.2.1.6 Class 6 Weld Joints

a. This covers plug and slot weld joints as applicable to the requirements of the project's code(s).

1.3 GENERAL REQUIREMENTS

1.3.1 Conform the design of welded connections to AISC 360, unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

1.3.2 The Contractor shall receive and have present a current burn permit for all welding.

1.4 SUBMITTALS

1.4.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.4.1.1 SD-03 Product Data

a. Welding Procedure Qualifications
b. Welder, Welding Operator, and Tacker Qualification
c. Inspector Qualification
d. Previous Qualifications
e. Pre-qualified Procedures

(1) Copies of the welding procedure specifications; the procedure qualification test records; and the welder, welding operator, or tacker qualification test records.

1.4.1.2 SD-06 Test Reports

a. Quality Control
b. Nondestructive Examination

(1) Provide a quality assurance plan and records of tests and inspections. Submit all records of nondestructive examination in accordance with paragraph STANDARDS OF ACCEPTANCE.

1.4.1.3 SD-07 Certificates

a. Certified Welding Procedure Specifications (WPS)
b. Certified Brazing Procedure Specifications (BPS)
c. Certified Procedure Qualification Records (PQR)
d. Certified Welder Performance Qualifications (WPQ)
e. Certified Brazer Performance Qualifications (BPQ)

(1) Provide certificates in accordance with paragraph "Other Applications".

1.5 WELDING PROCEDURE QUALIFICATIONS

1.5.1 Except for pre-qualified (per AWS D1.1) and previously qualified procedures, each Contractor performing welding shall record in detail and qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Conform qualification of welding procedures to AWS D1.1 and to the specifications in this section. Submit for approval copies of the welding procedure specification and the results of the procedure qualification test for each type of welding which requires procedure qualification. Approval of any procedure, however, does not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the specified requirements. Submit this information on the forms in Appendix E of AWS D1.1. Individually identify and clearly reference on the detail drawings and erection drawings all welding procedure specifications, or suitably key them to the contract drawings. In case of conflict between this specification and AWS D1.1, this specification governs.

1.5.1.1 General Requirements:

1.5.1.2 The organization performing this work must be certified in the following: American Institute of Steel Construction (AISC) Quality Certification Program Category I Conventional Steel Structures.

1.5.1.3 For Structural Projects, provide documentation of the following:

a. Component Thickness 1/8 inch and greater: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.1.

b. Component Thickness Less than 1/8 inch: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.3.

c. Reinforcing Steel: Qualification documents (WPS, PWR, and WPQ) in accordance with AWS D1.4.

1.5.1.4 For other applications, provide documentation of the following:

a. Submit for approval to the Contracting Officer two copies of Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records (PQR) within fifteen calendar days after receipt of Notice to Proceed.

b. Cranes: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D14.1.

c. Submit for approval to the Contracting Officer two copies of Certified Welder Performance Qualifications (WPQ) and Certified Brazer Performance Qualifications (BPQ) within fifteen calendar days prior to any employee welding on the project material.

d. Machinery: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D14.4.

1.5.1.5 Previous Qualifications:

1.5.1.6 Welding procedures previously qualified by test may be accepted for this contract without re-qualification if the following conditions are met:

a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.5.1.7 Pre-qualified Procedures:

1.5.1.8 Welding procedures which are considered pre-qualified as specified in AWS D1.1 will be accepted without further qualification. The Contractor shall submit for approval a listing or an annotated drawing to indicate the joints not pre-qualified. Procedure qualification is mandatory for these joints

1.5.1.9 Retests:

1.5.1.10 If welding procedure fails to meet the requirements of AWS D1.1, the procedure specification must be revised and re-qualified, or at the Contractor's option, welding procedure may be retested in accordance with AWS D1.1. If the welding procedure is qualified through retesting, all test results, including those of test welds that failed to meet the requirements, must be submitted with the welding procedure.

1.6 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

1.6.1 Each welder, welding operator, and tacker assigned to work on this contract must be qualified in accordance with the applicable requirements of AWS D1.1 and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

1.6.1.1 Previous Personnel Qualifications

a. At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without re-qualification if all the following conditions are met:

(1) Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.

(2) Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

(3) The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

(4) The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.6.1.2 Certificates

a. Before assigning any welder, welding operator, or tacker to work under this contract, submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is qualified as specified. The certification must state the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. Keep the certification current, on file, and furnish 3 copies.

1.6.1.3 Renewal of Qualification

a. Re-qualification of a welder or welding operator is required under any of the following conditions:

(1) It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.

(2) There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.

(3) The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Submit as evidence of conformance all records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified.

(4) A tacker who passes the qualification test is considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker is required to pass the prescribed tack welding test.

1.7 INSPECTOR QUALIFICATION

1.7.1 Inspector qualifications must be in accordance with AWS D1.1. Qualify all nondestructive testing personnel in accordance with the requirements of ASNT RP SNT-TC-1A for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT RP SNT-TC-1A, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

1.8 SYMBOLS

1.8.1 Symbols must be in accordance with AWS A2.4, unless otherwise indicated.

1.9 SAFETY

1.9.1 Safe welding practices and safety precautions during welding must conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING EQUIPMENT AND MATERIALS

2.1.1 All welding equipment, electrodes, welding wire, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1. Welding electrodes shall be E70XX unless noted otherwise.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

3.1.1.1 Conform workmanship and techniques for welded construction to the requirements of AWS D1.1 and AISC 360. When AWS D1.1 and the AISC 360 specification conflict, the requirements of AWS D1.1 govern.

3.1.2 Identification

3.1.2.1 Identify all welds in one of the following ways:

a. Submit written records to indicate the location of welds made by each welder, welding operator, or tacker.

b. Identify all work performed by each welder, welding operator, or tacker with an assigned number, letter, or symbol to identify welds made by that individual. The Contracting Officer

may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. Place the identification mark for seam welds adjacent to the weld at 3 foot intervals. Identification with die stamps or electric etchers is not allowed.

3.2 QUALITY CONTROL

3.2.1 Perform testing using an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. Perform visual and radiographic, ultrasonic, magnetic particle, or dye penetrant inspections as appropriate to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Conform procedures and techniques for inspection with applicable requirements of AWS D1.1, ASTM E 165, ASTM E 709, except that in radiographic inspection only film types designated as "fine grain," or "extra fine," are acceptable.

3.3 STANDARDS OF ACCEPTANCE

3.3.1 Conform dimensional tolerances for welded construction, details of welds, and quality of welds with the applicable requirements of AWS D1.1 and the contract drawings. Perform visual inspection and nondestructive testing by radiographic, ultrasonic, magnetic particle, or dye penetrant methods as appropriate. Provide visual inspection on 100 percent of all welds. The minimum extent of nondestructive testing must be 100 percent for complete and partial penetration welds and must be random 10 percent for all other welds.

3.3.1.1 Nondestructive Examination

a. The welding is subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop do not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment.

3.3.1.2 Destructive Tests

a. Make all repairs when metallographic specimens are removed from any part of a structure. Employ only qualified welders or welding operators, and use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.4 GOVERNMENT INSPECTION AND TESTING

3.4.1 In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.5 CORRECTIONS AND REPAIRS

3.5.1 If inspection or testing indicates defects in the weld joints, repair defective welds using a qualified welder or welding operator as applicable. Conduct corrections in accordance with the requirements of AWS D1.1 and the specifications. Repair all defects in accordance with the approved procedures. Repair defects discovered between passes before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, blend the affected area into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before re-welding, examine the area by suitable methods to ensure that the defect has been eliminated. Repaired welds shall meet the inspection requirements for the original welds. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

a. AASHTO HB-17 Standard Specifications for Highway Bridges

1.1.1.2 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

a. AISC 303 Code of Standard Practice for Steel Buildings and Bridges

b. AISC 325 Steel Construction Manual

c. AISC 326 Detailing for Steel Construction

d. AISC 341 Seismic Provisions for Structural Steel Buildings

e. AISC 348 Specification for Structural Joints Using ASTM A325 or A490 Bolts

f. AISC 360 Specification for Structural Steel Buildings, with Commentary

g. AISC 810 Erection Bracing of Low-Rise Structural Steel Frames

h. AISC FCD Quality Certification Program Description

1.1.1.3 AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

a. AREMA Manual Manual for Railway Engineering

1.1.1.4 AMERICAN WELDING SOCIETY (AWS)

a. AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination

b. AWS D1.1 Structural Welding Code - Steel

1.1.1.5 ASME INTERNATIONAL (ASME)

a. ASME B46.1 Surface Texture (Surface Roughness, Waviness and Lay)

1.1.1.6 ASTM INTERNATIONAL (ASTM)

a. ASTM A 108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

b. ASTM A 123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
c. ASTM A 143	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
d. ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
e. ASTM A 242	Standard Specification for High-Strength Low-Alloy Structural Steel
f. ASTM A 276	Standard Specification for Stainless Steel Bars and Shapes
g. ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
h. ASTM A 325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
i. ASTM A 36	Standard Specification for Carbon Structural Steel
j. ASTM A 490	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
k. ASTM A 500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
l. ASTM A 501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
m. ASTM A 514	Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
n. ASTM A 529	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
o. ASTM A 53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
p. ASTM A 563	Standard Specification for Carbon and Alloy Steel Nuts
q. ASTM A 572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
r. ASTM A 588	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point, with Atmospheric Corrosion Resistance

s.	ASTM A 6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
t.	ASTM A 618	Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
u.	ASTM A 668	Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
v.	ASTM A 709	Standard Specification for Structural Steel for Bridges
w.	ASTM A 780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
x.	ASTM A 852	Standard Specification for Quenched and Tempered Low-Alloy Structural Steel Plate with 70 ksi Minimum Yield Strength to 4 in. Thick
y.	ASTM A 992	Standard Specification for Structural Steel Shapes
z.	ASTM B 695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
aa.	ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
bb.	ASTM C 827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
cc.	ASTM F 436	Standard Specification for Hardened Steel Washers
dd.	ASTM F 844	Washers, Steel, Plain (Flat), Unhardened for General Use
ee.	ASTM F 959	Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
ff.	ASTM F 1852	Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

1.1.1.7 CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

a.	CMAA 70	Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

1.1.1.8 THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

a.	SSPC PA 1	Shop, Field, and Maintenance Painting of Steel
b.	SSPC PS 13.01	Epoxy-Polyamide Painting System

c. SSPC Paint 25 Paint Specification No. 25 Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II

d. SSPC SP 3 Power Tool Cleaning

e. SSPC SP 6 Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

1.2.1 Provide the structural steel system, including shop primer or galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 325 except as modified in this contract.

1.3 MODIFICATIONS TO REFERENCES

1.3.1 Conform to AISC 360, AISC 303, AISC 341, AISC 348, and AISC 325, except as modified in this section.

1.4 SUBMITTALS

1.4.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.4.1.1 SD-02 Shop Drawings

a. Erection Plan, including description of temporary supports

b. Fabrication drawings including description of connections

1.4.1.2 SD-03 Product Data

a. Shop primer

b. Welding electrodes and rods

c. Load indicator washers

d. Non-Shrink Grout

e. Load indicator bolts

f. Include test report for Class B primer.

1.4.1.3 SD-06 Test Reports

a. Class B coating

b. Bolts, nuts, and washers

c. Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

1.4.1.4 SD-07 Certificates

a. Steel

b. Bolts, nuts, and washers

c. Galvanizing

d. Pins and rollers

e. AISC Quality Certification

f. Overhead, top running crane rail beam

g. Welding procedures and qualifications

1.5 AISC QUALITY CERTIFICATION

1.5.1 Work shall be fabricated in an AISC certified Category I fabrication plant.

1.6 SEISMIC PROVISIONS

1.6.1 The structural steel system shall be provided in accordance with AISC 341.

1.7 QUALITY ASSURANCE

1.7.1 Drawing Requirements

1.7.1.1 Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326 and AISC 325. Fabrication drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Miscellaneous Structural Steel shall be ASTM A36 unless noted otherwise.

2.1.2 Wide flange (W) steel sections shall be ASTM A992 unless noted otherwise.

2.1.3 M, S, C, MC, and L shapes shall be ASTM A36.

2.1.4 Round Hollow Structural Sections (HSS) shall be ASTM A500, Grade B, 42 ksi.

2.1.5 Rectangular Hollow Structural Sections (HSS) shall be ASTM A500, Grade B, 46 ksi.

2.1.6 HP shapes shall be ASTM A572, Grade 50.

2.1.7 Pipe shall be ASTM A53, Grade B.

2.2 BOLTS, NUTS, AND WASHERS

2.2.1 Miscellaneous connections.

2.2.1.1 Structural Steel, Steel Pipe

2.2.1.2 Bolts

a. ASTM A 307, Grade A; unless noted otherwise.

2.2.1.3 Nuts

a. ASTM A 563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.1.4 Washers

a. ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436 washers for ASTM A 325 and ASTM A 490 bolts.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

a. ASTM A 325, Type 1 or ASTM A 490, Type 1 or 2.

2.2.2.2 Nuts

a. ASTM A 563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

a. ASTM F 436.

2.2.3 Weathering Structural Steel

2.2.3.1 Bolts

a. ASTM A 325, Type 3; ASTM A 490, Type 3.

2.2.3.2 Nuts

a. ASTM A 563, heavy hex style, Grade DH3, except Grade C3 may be furnished for ASTM A 325 bolts.

2.2.3.3 Washers

a. ASTM F 436, weathering steel.

2.2.4 Foundation Anchorage

2.2.4.1 Anchor Rods

a. ASTM F 1554, Grade 36.

2.2.4.2 Anchor Nuts

a. As recommended in ASTM F 1554.

2.2.4.3 Anchor Washers

a. As recommended in ASTM F 1554.

2.2.5 Load Indicator Washers

a. ASTM F 959.

2.2.6 Load Indicator (Tension Control) Bolts/Nuts/Washers

a. ASTM F 1852.

2.2.7 Self-Locking Nuts

2.2.7.1 Provide nuts with a locking pin set in the nut. The locking pin shall slide along the bolt threads, and by reversing the direction of the locking pin, the nut shall be removed without damaging the nut or bolt. Provide stainless steel locking pins.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Non-Shrink Grout

a. ASTM C 1107, with no ASTM C 827 shrinkage. Grout shall be nonmetallic.

2.3.2 Welded Shear Stud Connectors

a. AWS D1.1.

2.3.3 Pins and Rollers

a. ASTM A 668, Class C, D, F, or G; ASTM A 108, Grades 1016 to 1030. Provide as specified in AASHTO HB-17, Division II, Sections 10.26 and 10.27, except provide pins in lengths to extend a minimum of 0.25 inch beyond the outside faces of the connected parts.

2.4 SHOP PRIMER

a. SSPC Paint 25, (alkyd primer) or SSPC PS 13.01 epoxy-polyamide, green primer (Form 150) type 1, except provide a Class B coating in accordance with AISC 325 for slip critical joints.

Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

2.5 GALVANIZING

a. ASTM A 123 or ASTM A 153, as applicable, unless specified otherwise. Galvanize after fabrication where practicable.

2.6 OVERHEAD, TOP RUNNING CRANE RAIL

a. AISC 325 crane rail section and bolted joints. Provide rail fasteners and a minimum rail length of 10 feet.

2.7 FABRICATION

2.7.1 Markings

2.7.1.1 Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded or on surfaces of weathering steels that will be exposed in the completed structure. Do not locate match markings in areas that will decrease member strength or cause stress concentrations

2.7.2 Shop Primer

2.7.2.1 Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, surfaces to receive sprayed-on fireproofing, surfaces to receive epoxy coatings, surfaces designed as part of a composite steel concrete section that are in contact with the concrete, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking is to be welded). Slip critical surfaces shall be primed with a Class B coating. Prior to assembly, prime surfaces before concealment or inaccessibility after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer.

2.7.2.2 Cleaning

a. SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.7.2.3 Primer

a. Apply primer to a minimum dry film thickness of 2.0 mil. Provide the Class B coating for slip critical joints in accordance with the coating manufacturer's recommendations. Repair damaged primed surfaces with an additional coat of primer.

2.7.3 Fireproofing and Epoxy Coated Surfaces

2.7.3.1 Surfaces to receive sprayed-on fireproofing or epoxy coatings shall be cleaned and prepared in accordance with the manufacturer's recommendations, and as specified in Section 07 81 00 SPRAY-APPLIED FIREPROOFING.

2.7.4 Surface Finishes

2.7.4.1 ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

2.8 DRAINAGE HOLES

2.8.1.1 Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2 inch and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

PART 3 EXECUTION

3.1 FABRICATION

3.1.1 Fabrication shall be in accordance with the applicable provisions of AISC 325. Fabrication and assembly shall be done in the shop to the greatest extent possible.

3.1.2 Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6.

3.1.3 Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting primed with the specified paint.

3.1.4 Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

3.1.5 Do not splice truss top and bottom chords of trusses except as approved by the Contracting Officer. Chord splices shall occur at panel joints at approximately the third point of the span. The center of gravity lines of truss members shall intersect at panel points unless otherwise approved by the Contracting Officer. When the center of gravity lines do not intersect at a panel point, provisions shall be made for the stresses due to eccentricity. Camber of trusses shall be 1/8 inch in 10 feet unless otherwise indicated.

3.2 INSTALLATION

3.2.1 Overhead, Top Running Cranes

3.2.1.1 Runway rails and beams shall be provided in accordance with AISC 325 and CMAA 70, except that in case of conflict, the requirements of CMAA 70 shall govern. In addition, provide a maximum vertical difference of 0.03 inch in the elevation between adjacent runway rail tops and adjacent runway beam tops at joints. Provide adjustable runway support connections to allow placement of the crane rails and beams to the tolerances specified. Stagger runway rail joints a minimum of one foot, except that the stagger shall not be the same as the crane wheel spacing.

3.3 ERECTION

3.3.1 Erection of structural steel, except as indicated below, shall be in accordance with the applicable provisions of AISC 325.

3.3.2 For low-rise structural steel buildings 60 feet tall or less and a maximum of 2 stories, the erection plan shall conform to AISC 303 and the structure shall be erected in accordance with AISC 810.

3.3.3 After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.4 STORAGE

3.4.1 Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.5 CONNECTIONS

a. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt and pin holes perpendicular to the surface of the member. Holes shall not be cut or enlarged by burning. Bolts, nuts, and washers shall be clean of dirt and rust and lubricated immediately prior to installation.

3.5.2 Non Slip-Critical Bolts

3.5.2.1 ASTM A 307, ASTM A 325, and ASTM A 49. Bolts not identified in the slip-control bolts section below shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.5.3 Slip-Critical Bolts

3.5.3.1 All connections for joints defined in AISC 348 Sections 4.2 and 4.3 and all connections designated as slip-critical and/or axial tension type connections shall be tightened to a slip-critical level.

3.5.3.2 Bolts tightened to a slip-critical level shall be fully tensioned to 70 percent of their minimum tensile strength with the use of load indicator bolts or washers. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

3.5.3.3 Installation of Load Indicator Washers (LIW)

a. ASTM F 959. Where possible, the LIW shall be installed under the bolt head and the nut shall be tightened. If the LIW is installed adjacent to the turned element, provide a flat ASTM F 436 washer between the LIW and nut when the nut is turned for tightening, and between the LIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat ASTM F 436 washers under both the bolt head and nut when ASTM A 490 bolts are used.

3.6 GAS CUTTING

3.6.1 The use of a heat to correct fabrication errors must be approved by the Contracting Officer prior to use.

3.7 SHOP PRIMER REPAIR

a. Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.7.1 Field Priming

3.7.1.1 Field prime steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.8 GALVANIZING REPAIR

3.8.1 Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.9 FIELD QUALITY CONTROL

a. Perform field tests, and provide labor, equipment, and incidentals required for testing. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.9.1 Welds

3.9.1.1 Visual Inspection

a. AWS D1.1. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections per Specification Section 05 05 23, Welding, Structural.

3.9.1.2 Nondestructive Testing

a. AWS D1.1. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections per Specification Section 05 05 23, Welding, Structural.

3.9.2 Load Indicator Washers

3.9.2.1 Load Indicator Washer Compression

a. Load indicator washers shall be tested in place to verify that they have been compressed sufficiently to provide the 0.015 inch gap when the load indicator washer is placed under the bolt head and the nut is tightened, and to provide the 0.005 inch gap when the load indicator washer is placed under the turned element, as required by ASTM F 959.

3.9.2.2 Load Indicator Gaps

a. In addition to the above testing, an independent testing agency as approved by the Contracting Officer, shall test in place the load indicator gaps on 20 percent of the installed load indicator washers to verify that the ASTM F 959 load indicator gaps have been achieved. If more than 10 percent of the load indicators tested have not been compressed sufficiently to provide the average gaps required by ASTM F 959, then all in place load indicator washers shall be tested to verify that the ASTM F 959 load indicator gaps have been achieved. Test locations shall be selected by the Contracting Officer.

3.9.3 Overhead, Top Running Crane Rails and Beams

3.9.3.1 Runway rails and beams shall be surveyed (horizontally and vertically) after installation to verify compliance with the tolerance requirements of CMAA 70 and the additional tolerance requirements specified in this section. After each survey, submit a written report to the Contracting Officer with the following information: field survey results, tolerance requirements, areas out of tolerance, and proposed corrective measures. Proposed corrective measures shall be approved by the Contracting Officer. Following completion of corrective measures, areas that were previously out of tolerance shall be re-surveyed and another written report shall be furnished to the Contracting Officer. Field surveys shall be performed and sealed by a registered land surveyor.

3.9.4 High-Strength Bolts

3.9.4.1 Inspection

a. Inspection procedures shall be in accordance with AISC 348, Section 9. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

b. The Contractor shall inspect proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of torque wrenches for high-strength bolts.

c. The Contractor shall inspect high-strength bolted connections in accordance with AISC 348.

3.9.4.2 Testing

a. The Government has the option to perform nondestructive tests on 5 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations shall be selected by the Contracting Officer. If more than 10 percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, shall be tested. Retest new bolts after installation.

3.9.5 Testing for Embrittlement

a. Steel products that are hot dip galvanized after they have been fabricated shall be tested in accordance with ASTM A143.

3.10 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

3.10.1 As indicated on the drawings.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN IRON AND STEEL INSTITUTE (AISI)

a. AISI SPEC — North American Specification for the Design of Cold-Formed Steel Structural Members

b. AISI MANUAL — Cold-Formed Steel Design Manual

1.1.1.2 AMERICAN WELDING SOCIETY (AWS)

a. AWS D1.3 — Structural Welding Code - Sheet Steel

1.1.1.3 ASTM INTERNATIONAL (ASTM)

a. ASTM A 1008 — Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

b. ASTM A 1011 — Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

c. ASTM A 123 — Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

d. ASTM A 153 — Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

e. ASTM A 370 — Standard Test Methods and Definitions for Mechanical Testing of Steel Products

f. ASTM A 653 — Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

g. ASTM B 633 — Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

h. ASTM C 955 — Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases

i. ASTM E 329 — Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.1.1.4 SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

a. SAE J78 Steel Self Drilling Tapping Screws

1.1.1.5 THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

a. SSPC Paint 25 SSPC-Paint 25, Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Framing Components

(1) Contractor shall provide cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.

(2) Connection details showing fastener type, quantity, location, and other information to assure proper installation.

(3) Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

1.2.1.2 SD-03 Product Data

a. Steel studs, joists, tracks, bracing, bridging and accessories

b. Fasteners

1.2.1.3 SD-05 Design Data

a. Metal framing calculations

1.2.1.4 SD-07 Certificates

a. Load-bearing cold-formed metal framing

(1) Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E 329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A 370.

b. Welds

(1) Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Deliver materials to job site and store in adequately ventilated, dry locations. Storage area shall permit easy access for inspection and handling. If necessary to store materials outside, stack off the ground, support on a level platform, and protect from the weather as approved. Handle materials to prevent damage. Finish of the framing members shall be maintained at all times, using approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust. Replace damaged items with new, as directed by the Contracting Officer.

1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

1.4.1 Include top and bottom tracks, bracing, fastenings, and other accessories necessary for complete installation. Framing members shall have the structural properties indicated. Where physical structural properties are not indicated, they shall be as necessary to withstand all imposed loads. Design framing in accordance with AISI SPEC. Non-load-bearing metal framing, furring, and ceiling suspension systems are specified in Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD. Metal suspension systems for acoustical ceilings are specified in Section 09 51 00 ACOUSTICAL CEILINGS.

1.5 MAXIMUM DEFLECTION

1.5.1 Exterior Studs:

1.5.1.1

Deflection Criteria	Exterior Finish
L/240	Synthetic Plaster, Metal Panels
L/360	Cement Plaster, Wood Veneer
L/600	Brick Veneer, Stone Panels

1.5.2 Wall deflections shall be computed on the basis that studs withstand all lateral forces independent of any composite action from sheathing materials. Studs abutting windows or louvers shall also be designed not to exceed 1/4 inch maximum deflection.

1.5.2.1 Floor Joists:

a. L/360 - Live load only
b. L/240 - Total load

1.5.2.2 Roof Rafters:

a. L/240 - Live load only

1.6 QUALITY ASSURANCE

1.6.1 Drawing Requirements

1.6.1.1 Submit framing components drawings to show sizes, thicknesses, layout, material designations, methods of installation, and accessories.

1.6.2 Design Data Required

1.6.2.1 Submit metal framing calculations to verify sizes, gages, and spacing of members and connections. Show methods and practices used in installation.

PART 2 PRODUCTS

2.1 STEEL STUDS, JOISTS, TRACKS, BRACING, BRIDGING AND ACCESSORIES

2.1.1 Framing components shall comply with ASTM C 955 and the following.

2.1.1.1 Studs and Joists of 16 Gage (0.0566 Inch) and Heavier

a. Galvanized steel, ASTM A 653, SS Grade 50, G60.

2.1.1.2 Studs and Joists of 18 Gage (0.0451 Inch) and Lighter, Track and Accessories (All Gages)

a. Galvanized steel, ASTM A 653, SS, Grade 33, G60.

2.1.1.3 Sizes, Gages, Section Modulus, and Other Structural Properties

a. Size and gage as indicated.

2.2 MARKINGS

2.2.1 Studs and track shall have product markings stamped on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following:

2.2.1.1 Manufacturer's identification.

2.2.1.2 Minimum delivered uncoated steel thickness.

2.2.1.3 Protective coating designator.

2.2.1.4 Minimum yield strength.

2.2.1.5 The dimensional data provided in accordance with AISI General Provisions, paragraph A5.2.

2.3 CONNECTIONS

2.3.1 Screws for steel-to-steel connections shall be self-drilling tapping in compliance with SAE J78 of the type, size, and location as shown on the drawings. Electroplated screws shall have a Type II coating in accordance with ASTM B 633. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A 123 or ASTM A 153 as appropriate.

2.4 PAINT

2.4.1 Ungalvanized steel, if used, shall be thoroughly cleaned, phosphate treated, and coated with corrosion-inhibiting primer, SSPC Paint 25.

2.5 PLASTIC GROMMETS

2.5.1 Supply plastic grommets, recommended by stud manufacturer, to protect electrical wires. Prevent metal to metal contact for plumbing pipes.

PART 3 EXECUTION

3.1 FASTENING

3.1.1 Fasten framing members together by welding or by using self-drilling or self-tapping screws. Electrodes and screw connections shall be as required and indicated on the contract drawings.

3.1.1.1 Welds

a. All welding shall be performed in accordance with AWS D1.3. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 18 gage.

3.1.1.2 Screws

a. Screws shall be of the type, size, and location shown on the drawings. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI SPEC. Screws covered by sheathing materials shall have low profile heads.

3.1.1.3 Anchors

a. Anchors shall be of the type, size, and location shown on the drawings.

3.2 INSTALLATION

3.2.1 Tracks

3.2.1.1 Provide accurately aligned tracks at top and bottom of partitions. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 3 inches from the edge of concrete slabs.

3.2.2 Studs

3.2.2.1 Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 2 feet wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI SPEC, consisting of, as a minimum, runner channel cut to fit between and welded to the studs or hot- or cold-rolled steel channels inserted through cutouts in web of each stud and secured to studs with welded clip angles. Bracing shall be not less than the following:

LOAD	HEIGHT	BRACING

Wind load only	Up to 10 feet	One row at mid-height
	Over 10 feet	Rows 5'-0" o.c. maximum
Axial load	Up to 10 feet	Two rows at 1/3 points
	Over 10 feet	Rows 3'-4" o.c. maximum

3.2.3 Joists and Trusses

3.2.3.1 Locate each joist or truss directly above a stud. Provide doubled joists under parallel partitions wherever partition length exceeds 1/2 of joist span. Joists shall have at least 2.50 inches of bearing on steel, 4 inches on masonry, and shall be reinforced over bearings where required to prevent web crippling. Splice joists over bearings only. Lap and weld splices as indicated. Provide manufacturer's standard bridging which shall not be less than the following:

CLEAR SPAN	BRIDGING
Up to 14 feet	One row near center
14 to 20 feet	Two rows at 1/3 points
20 to 26 feet	Three rows at 1/4 points
26 to 32 feet	Four rows at 1/5 points

3.2.3.2 Temporary bracing shall be provided and remain in place until work is permanently stabilized.

3.2.4 Erection Tolerances

3.2.4.1 Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

(1) Layout of walls and partitions: 1/4 inch from intended position;

(2) Plates and runners: 1/4 inch in 8 feet from a straight line;

(3) Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/4 inch in 8 feet from a true plane.

b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

(1) Layout of walls and partitions: 1/4 inch from intended position;

(2) Plates and runners: 1/8 inch in 8 feet from a straight line;

(3) Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/8 inch in 8 feet from a true plane.

3.2.5 Provide Special Inspection and Testing for Seismic-Resisting Systems as indicated on the Drawings.

**** END OF SECTION ****

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2010) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.3	(2013) Operations - Safety Requirements for Powder Actuated Fastening Systems

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)
ASME B18.22M	(1981; R 2010) Metric Plain Washers

ASME B18.6.2	(1998; R 2010) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2013) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A467/A467M	(2007; R 2012) Standard Specification for Machine Coil Chain
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
ASTM A475	(2003; R 2014) Standard Specification for Zinc-Coated Steel Wire Strand
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A500/A500M	(2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM A786/A786M	(2015a) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2016) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B108/B108M	(2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings
ASTM C1513	(2013) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D1187/D1187M	(1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D2047	(2011) Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
ASTM E488/E488M	(2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM F1267	(2015) Metal, Expanded, Steel

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2009) Metal Bar Grating Manual
NAAMM MBG 532	(2009) Heavy Duty Metal Bar Grating Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211 (2016) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3 (1982; E 2004) Power Tool Cleaning

SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

SD-02 Shop Drawings

Fabrication Drawings of Structural Steel Door Frames

Access Doors and Panels, Installation Drawings

Cover Plates and Frames, Installation Drawings

Expansion Joint Covers, Installation Drawings

Floor Gratings and Roof Walkways, Installation Drawings

Wheel Guards, Installation Drawings

Window[And Door] Guards, Installation Drawings

Embedded Angles and Plates, Installation Drawings

Roof Hatch

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data

Access Doors and Panels

Cover Plates and Frames

Control-Joint Covers

Expansion Joint Covers

Floor Gratings and Roof Walkways

Structural Steel Door Frames

Wheel Guards

Window and Door Guards

Roof Hatch

SD-04 Samples

Expansion Joint Covers

Control-Joint Covers

Provide full size samples, taken from manufacturer's stock, and be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M, Grade B.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.1.5 Gratings

a. Gray cast iron ASTM A48/A48M, Class 40.

b. Metal plank grating, non-slip requirement, aluminum ASTM B209M (ASTM B209), 6061-T6; steel ASTM A653/A653M, Z275 (G90).

c. Metal bar type grating NAAMM MBG 531.

2.1.6 Floor Plates, Patterned

Floor plate ASTM A786/A786M. Steel plate shall not be less than 1.9 mm (14 gage).

2.1.7 Anchor Bolts

ASTM A307. Where exposed, shall be of the same material, color, and finish as the metal to which applied.

2.1.7.1 Expansion Anchors, Sleeve Anchors and Adhesive Anchors

Provide expansion anchors,sleeve anchors and adhesive anchors as indicated. Minimum concrete or masonry embedment shall be as indicated. Design values shall be as tested according to ASTM E488/E488M.

2.1.7.2 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.7.3 Toggle Bolts

ASME B18.2.1.

2.1.7.4 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 or ASTM A307.

2.1.7.5 Powder Actuated Fasteners

Follow safety provisions of ASSE/SAFE A10.3.

2.1.7.6 Screws

ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.1.7.7 Washers

Provide plain washers to conform toASME B18.22M(ASME B18.21.1). Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.2M(ASME B18.21.1).

2.1.8 Aluminum Alloy Products

Conform to ASTM B209M (ASTM B209) for sheet plate, ASTM B221M (ASTM B221) for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 3 mm (1/8 inch) thick and aluminum plate or sheet at least 1.3 mm (0.050 inch) thick.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 (G90), as applicable.

2.2.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop.

2.2.4.2 Pretreatment, Priming and Painting

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 0.03 mm (1.0 mil). Tint additional prime coat with a small amount of tinting pigment.

2.2.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.6 Aluminum Surfaces

2.2.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2.6.2 Aluminum Finishes

Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with a standard mill finish. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF45. Provide a polished satin finish on items to be anodized.

2.3 ACCESS DOORS AND PANELS

Provide flush type access doors and panels unless otherwise indicated. Fabricate frames for access doors of steel not lighter than 1.9 mm (14 gage) with welded joints and anchorage for securing into construction. Provide access doors with a minimum of 350 by 500 mm (14 by 20 inches) and of not lighter than 1.9 mm (14 gage) steel, with stiffened edges and welded attachments. Provide access doors hinged to frame and with a flush-face, turn-screw-operated latch. Provide exposed metal surface with a baked enamel finish.

2.4 CONTROL-JOINT COVERS

Provide control-joint covers to be located on wall surfaces of concrete, masonry and tile work. Provide protective coating on the surface in contact with concrete, masonry or tile.

2.5 CORNER GUARDS AND SHIELDS

For jambs and sills of openings and edges of platforms provide steel shapes and plates anchored in masonry or concrete with welded steel straps or end-weld stud anchors. Form corner guards for use with glazed or ceramic tile finish on walls with 1.6 mm (0.0625 inch) thick corrosion-resisting steel with polished or satin finish, extend 1.5 m (5 feet) above the top of cove base or to the top of the wainscot, whichever is less, and securely anchor to the supporting wall. Corner guards on exterior shall be galvanized.

2.6 COVER PLATES AND FRAMES

Fabricate cover plates of 6 mm (1/4 inch) thick rolled steel weighing not more than 45 kg (100 pounds) per plate with a slip-resistant, carbon steel conforming to ASTM A283/A283M having a minimum static coefficient of friction of 0.50 when tested in accordance with ASTM D2047. On wearing surfaces provide aluminum oxide or silicon carbide. Plate shall be shop painted. Reinforce to sustain a live load of 101 MPa (100 pounds per square foot). Frames shall be structural steel shapes and plates, securely fastened to the structure as indicated. Miter and weld all corners. Butt joint straight runs. Allow for expansion on straight runs over 4500 mm (15 feet). Provide holes for lifting tools. Provide flush drop handles for removal formed from 6 mm (1/4 inch) round stock where indicated. Provide holes and openings with 13 mm (1/2 inch) clearance for pipes and equipment. Remove sharp edges and burrs from cover plates and exposed edges of frames. Weld all connections and grind top surface smooth. Weld bar stops every six inches. Provide 3 mm (1/8 inch) clearance at edges and between cover plates.

2.7 EXPANSION JOINT COVERS

Provide expansion joint covers constructed of extruded aluminum with anodized satin aluminum finish for walls and ceilings and with standard mill finish for floor covers and exterior covers. Furnish plates, backup angles, expansion filler strip and anchors as indicated.

2.8 EXTRUDED FLOOR MAT FRAMES

Provide recess frames for roll-up floor mats of extruded 6063-T5 aluminum, in sizes shown. Miter corners to ensure accurate fitting. Determine depth of recess by the mat thickness. Anchor frames in concrete with anchor pins or bolts. Provide roll-up mats of aluminum construction with carpet surface. Provide roll-up mats for use in level surface area.

2.9 FLOOR GRATINGS AND ROOF WALKWAYS

Design steel or aluminum grating in accordance with NAAMM MBG 531 for bar type grating or manufacturer's charts for plank grating. Galvanize steel floor gratings.

a. Design floor gratings to support a stress (live load) of 101 MPa (100 pounds per square foot) for the spans indicated, with maximum deflection of L/240.

b. NAAMM MBG 531, band edges of grating with bars of the same size as the bearing bars. Weld banding in accordance with the manufacturer's standard for trim unless otherwise indicated. Design tops of bearing bars, cross or intermediate bars to be in the same plane and match grating finish.

--or--

c. Anchor gratings to structural members with bolts, toggle bolts, or expansion shields and bolts.

d. Slip resistance requirements must exceed both wet and dry a static coefficient of friction of 0.5.

2.10 GAS-TIGHT MANHOLE COVER AND FRAME

Provide a heavy duty type made of ductile cast-iron with bolted lid, machined bearing surfaces and gasket grooves, continuous neoprene gasket, counter sunk bronze hex head cap screws, and concealed watertight pickholes. Provide frame with a 760 mm (30 inch) diameter clear opening. Maximum weight of frame and cover together to be 240 kg (530 pounds).

2.11 GUARD POSTS (BOLLARDS/PIPE GUARDS)

Provide 150 mm (6 inch) extra strong weight steel pipe as specified in ASTM A53/A53M. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 17 MPa (2500 psi).

2.12 MISCELLANEOUS PLATES AND SHAPES

Provide for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings and frames. Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions as indicated and as required to support wall loads over openings. Provide with connections and fasteners. Construct to have at least 200 mm (8 inches) bearing on masonry at each end.

Provide angles and plates, ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements according to ASTM A123/A123M.

2.13 SAFETY CHAINS

Construct safety chains of galvanized steel, straight link type, 5 mm (3/16 inch) diameter, with at least twelve links per 300 mm (foot), and with snap hooks on each end. Test safety chain in accordance with ASTM A467/A467M, Class CS. Provide snap hooks of boat type. Provide galvanized 10 mm (3/8 inch) bolt with 20 mm (3/4 inch) eye diameter for attachment of chain, anchored as indicated. Supply two chains, 100 mm (4 inches) longer than the

anchorage spacing, for each guarded area. Locate safety chain where indicated. Mount the top chain 1050 mm (feet 6 inches)[_____] above the floor and mount the lower chain 600 mm (2 feet) [_____] above the floor.

2.14 SECURITY GRILLES

Fabricate of channel frames with not less than two masonry anchors at each jamb and 12 mm (1/2 inch) hardened steel bars spaced not over 100 mm (4 inches) both ways and welded to frame. Provide 18 by 16 mesh screen and two layers of 6 mm (1/4 inch) hardware cloth clamped to frame.

2.15 STEEL PLATE WAINSCOTS FOR CONCRETE OR MASONRY COLUMNS

Shop bend to radius for round columns and at right angles for square and rectangular columns with slight 6 mm (1/4 inch) radius on corners, with no horizontal joints and not more than 2 vertical joints single strapped and butt welded with a thickness of 1/2".

2.16 STRUCTURAL STEEL DOOR FRAMES

[a. Provide frames as indicated. If not otherwise shown, construct frames of structural shapes, or shape and plate composite, to form a full depth channel shape with at least 40 mm (1 1/2 inch)outstanding legs. For single swing doors, provide continuous 16 by 40 mm (5/8 by 1 1/2 inch) bar stock stops at head and jambs. For freight elevator hoistway entrance, include a non-skid metal sill as indicated].

b. Where track, guides, hoods, hangers, operators, and other such accessories are required, provide support as indicated.

c. Provide jamb anchors near top, bottom, and at not more than 600 mm (24 inch) intervals. Provide the bottom of each jamb member with a clip angle welded in place with two 12 mm (1/2 inch) diameter floor bolts for adjustment.

Provide frames of rolled shapes as indicated. Miter and weld heads to jambs, or have riveted clip angle connections concealed in the finished work. Provide frames for swinging doors with 16 by 40 mm (5/8 by 1 1/2 inch) solid bar stops secured to the frame by welding or by 6 mm (1/4 inch) diameter countersunk machine screws spaced not more than 300 mm (12 inches) on centers. Stiffen head openings greater than 900 mm (3 feet) sufficient to limit deflection to not more than 2 mm (1/16 inch). Secure frames to masonry with zinc-coated metal anchors spaced not more than 750 mm (30 inches) on centers. Where necessary to engage the threads of machine screws for fastening hardware, back frames on inside faces with steel plates of suitable thickness; tap frames and reinforcing plates as necessary for the installation of hardware and other work. Countersink rivets and screw heads where exposed in the finished work. Grind welds smooth.

2.17 WHEEL GUARDS

Provide wheel guards of hollow, heavy-duty type cast iron conforming to ASTM A48/A48M, with shaped, half round top, at least 450 mm (18 inches) high, and designed to provide a minimum of 150 mm (6 inches) of protection.

2.18 WINDOW AND DOOR GUARDS, DIAMOND-MESH TYPE

Provide diamond-mesh window and door guards constructed of woven steel wire or expanded metal framed with hot-rolled or cold-formed structural steel shapes. Provide woven wire panels of 3.3 mm (10 gage), 40 mm (1 1/2 inch) mesh secured through weaving bar to 25 by 12 by 3 mm (one by 1/2 by 1/8 inch)thick channel frame. Miter and weld corners of frames. Provide expanded metal panels conforming to ASTM F1267. 38 mm (1-1/2 inches), Mount window and door guards on interior of window and door frame with not less than two tamperproof hinged butts mounted on wood jambs with 6 mm (1/4 inch) lag bolts, to masonry jamb with toggle bolts, or welded to metal jambs. Mount window and door guards on exterior of window frame with not less than two tamperproof hinged butts mounted on 25 by 12 by 3 mm (one by 1/2 by 1/8 inch) jamb channel attached as indicated to 50 by 6 mm (2 by 1/4 inch)plate anchored to wood jamb with 6 mm (1/4 inch) lag bolts; to masonry jamb with toggle bolts, or to concrete jambs and solid masonry jambs with expansion shields and bolts. Provide one additional butt for each 900 mm (3 foot) internal length of guard over 1500 mm (5 feet). Provide one tamperproof hasp and padlock, with access from the interior, for each butt used and installed on the jamb opposite to that hinged. Provide galvanized guards and accessories.

2.19 WINDOW[AND DOOR] GUARDS, WOVEN WIRE

Provide woven wire window and doo] guards of size necessary to completely fill opening. Construct guards with 10 mm (3/8 inch) round rod frame and 40 mm (1 1/2 inch) diamond-mesh of No. 10 U.S. Gage (3.4 mm) ((0.135 diameter)) wire; all material zinc-coated. Provide at least three hinge side clips on one side and two lock ring hasps on opposite side.

2.20 CHIMNEYS, VENTS, AND SMOKESTACKS

Design and construct chimneys and vents in accordance with NFPA 211. Form chimney connectors of not lighter than 1.01 mm (20 gauge) galvanized steel. Design and construct stacks to withstand a wind velocity of 90 mile/h in accordance with ASCE 7. Construct unlined stacks of black-steel plates not less than 5 mm (3/16 inch)thick conforming to ASTM A36/A36M. Weld seams and joints, except provide an angle flange for connection to the boiler, other equipment, and stack support.

2.21 CLEANOUT DOORS

Provide galvanized]cleanout doors with frames, and unless otherwise indicated sized to match flues. Provide a continuous flange and anchors for securing frames into masonry. The doors shall be smokeproof, hinged, and have fastening devices to hold the door closed.

2.22 COAL-HOPPER DOORS

Construct coal-hopper doors of galvanized steel plates and shapes and complete with frame, stops, wall box, hinges, and hasp or locktype latch. Weld joints and attachments.

2.23 DOWNSPOUT BOOTS

Provide cast iron downspout boots with receiving bells sized to fit downspouts.

2.24 FOUNDATION VENTS

Provide foundation vents of the same size as the masonry units or sized as indicated, and made of extruded aluminum with integral water stop and sliding interior closer or damper operable from the outside. Provide an insect screen at the back of the vent. Provide Louvered openings with top and bottom drip lips, and the net ventilating area with closer or damper open at least 35 percent of the gross wall opening. The frames shall have a structural strength adequate to permit use in masonry walls without a lintel.

2.25 GUY CABLES

Guy cables shall be prestretched, galvanized wire rope of the sizes indicated. Wire rope shall conform to ASTM A475, high strength grade with Class A coating. Guys shall have a factory attached clevis top-end fitting; a factory attached open-bridge strand socket bottom-end fitting; and be complete with oval eye, threaded anchor rods. Fittings and accessories shall be hot-dip galvanized.

2.26 WINDOW SUB-SILL

Provide window sub-sill of extruded aluminum alloy with size and design indicated. Provide not less than two anchors per window section for securing into mortar joints of masonry sill course. Provide sills for banks of windows with prefinished Kynar metal with hemmed edges.

2.27 WINDOW WELLS

Window wells shall be not lighter than 1.5 mm, (16 gauge,) corrugated sheet steel, hot-dip galvanized after fabrication with top edge of walls having a 19 mm (3/4 inch) bead or rolled top. Window wells shall be semicircular or semielliptical in form and shall overlap the window by at least 75 mm (3 inches) on each side. Removable cover, hot-dip galvanized after fabrication, consisting of steel bar grate with bars spaced at not more than50 mm (2 inch) centers and welded to 25 by 6 mm (1 by 1/4 inch) frame shall be designed to fit into and rest on top edge of window well.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners shall be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Form joints exposed to the weather shall be formed to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections of work in place and ground smooth. Provide a smooth finish on exposed surfaces of work in place and unless otherwise approved, flush exposed riveting. Mill joints where tight fits are required. Corner joints shall be coped or mitered, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fastened in place. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening miscellaneous metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 BUILT-IN WORK

Form for anchorage metal work built-in with concrete or masonry, or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.6 FINISHES

3.6.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.6.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, shall be free of rust, grease, dirt and other foreign matter.

3.6.3 Environmental Conditions

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 15 degrees C (5 degrees F) above the dew point of the surrounding air, or when surface

temperature is below 7 degrees C or over 35 degrees C (45 degrees F or over 95 degrees F), unless approved by the Contracting Officer.

3.7 ACCESS PANELS

Install a removable access panel not less than 300 by 300 mm (12 by 12 inches) directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

3.8 CONTROL-JOINT COVERS

Provide covers over control-joints and fasten on one side only with fasteners spaced to give positive contact with wall surfaces on both sides of joint throughout the entire length of cover.

3.9 COVER PLATES AND FRAMES

Install the tops of cover plates and frames flush with floor.

3.10 WHEEL GUARDS

Anchor guards to concrete or masonry in accordance with manufacturer's instructions. Fill hollow cores solid with concrete with minimum compressive strength of 17 MPa (2500 psi).

3.11 INSTALLATION OF CHIMNEYS, VENTS, AND SMOKESTACKS

Install chimneys and vents in accordance with NFPA 211. Provide a cleanout opening with a tight-fitting, hinged, cast-iron door and frame at the base of each smokestack. Provide a top band on stacks for attachment of painter's rigging. Provide roof housing, rain cap, downdraft diverter, fire damper, and other accessories required for a complete installation. Join sections of prefabricated lined stacks with acid-resisting high-temperature cement and steel draw bands. Provide means to prevent accumulation of water in the smokestack.

3.132 DOOR GUARD FRAME

Mount door guard frame over the glazed opening using 6 mm (1/4 inch) lag bolts on the interior of wood doors or tamperproof through bolts on the interior of metal doors.

3.13 INSTALLATION OF GUARD POSTS (BOLLARDS/PIPE GUARDS)

Set pipe guards vertically in concrete piers. Construct piers of, and the hollow cores of the pipe filled with, concrete having a compressive strength of 21 MPa (3000 psi).

3.14 INSTALLATION OF DOWNSPOUT BOOTS

Secure downspouts to building through integral lips with appropriate fasteners.

3.15 RECESSED FLOOR FRAMES & MATS

Verify field measurements prior to releasing materials for fabrication by the manufacturer. Use a mat frame to ensure recess accuracy in size, shape and depth. Form drain pit by blocking out concrete when frames are installed, dampproof after concrete has set. Assemble frames onsite and install so that upper edge will be level with finished floor surface. Screeded the concrete base inside the mat recess frame area using the edge provided by the frame as a guide and anchor into the cement with anchor pins a minimum of 610 mm (24 inches) on centers.

3.16 MOUNTING OF SAFETY CHAINS

Mount safety chains 1070 mm (3 feet 6 inches) and 610 mm (2 feet) above the floor.

3.17 STRUCTURAL STEEL DOOR FRAMES

Secure door frames to the floor slab by means of angle clips and expansion bolts. Weld continuous door stops to the frame or tap screwed with countersunk screws at no more than 450 mm (18 inch) centers, assuring in either case full contact with the frame. Make any necessary reinforcements and drill and tap the frames as required for hardware.

3.18 INSTALLATION OF WHEEL GUARDS

Fill wheel guards with concrete and anchor to the floor or the building according to the manufacturer's recommendations.

3.19 BAR-GRILLE WINDOW GUARDS

Securely anchor bar-grille window guards to masonry with 13 mm (1/2 inch) diameter prison-type screws or bolts and expansion shields, or other type of fastenings if the ends of such fastenings are welded to the adjoining metal grilles or otherwise made tamperproof in a satisfactory manner. Spanner-head screws or bolts are not considered prison-type fasteners.

3.20 DIAMOND MESH WINDOW AND DOOR GUARDS

Mount diamond mesh window guards on interior window frame with not less than two tamperproof hinged butts mounted on wood jambs. Provide one additional butt for each 900 mm (3 foot) internal length of guard over 1500 mm (5 feet). Install hasp and padlock on the jamb opposite to that hinged.

3.22 INSTALLATION OF WINDOW WELLS

Place window wells as shown with the walls securely anchored to foundation surface. Excavate the area within the well to the bottom of the well and covered with a 100 mm (4 inch) thick layer of coarse gravel or crushed rock.

-- End of Section --

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)

a. AF&PA T10 Wood Frame Construction Manual for One- and Two-Family Dwellings

b. AF&PA T101 National Design Specification (NDS) for Wood Construction

1.1.1.2 AMERICAN HARDBOARD ASSOCIATION (AHA)

a. ANSI A135.4 Basic Hardboard Standard

1.1.1.3 AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

a. AITC 111 Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection

b. AITC A190.1 Structural Glued Laminated Timber

c. AITC OT-01 Timber Construction Manual

1.1.1.4 AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

a. ALSC PS 20 American Softwood Lumber Standard

1.1.1.5 AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

a. AWPA C1 All Timber Products - Preservative Treatment by Pressure Processes

b. AWPA C2 Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes

c. AWPA C20 Structural Lumber Fire-Retardant Treatment by Pressure Processes

d. AWPA C27 Plywood - Fire-Retardant Treatment by Pressure Processes

e. AWPA C28 Standard for Preservative Treatment of Structural Glued Laminated Members and Lamination Before Gluing of Southern Pine, Coastal Douglas Fir, Hem-fir and Western Hemlock by Pressure Processes

f. AWPA C9 Plywood - Preservative Treatment by Pressure Processes

g.	AWPA M2	Standard for Inspection of Treated Wood Products
h.	AWPA M6	Brands Used on Forest Products
i.	AWPA P17	Fire Retardant Formulations
j.	AWPA P18	Nonpressure Preservatives
k.	AWPA P5	Standard for Waterborne Preservatives
l.	AWPA T1	Use Category System: Processing and Treatment Standard
m.	AWPA U1	Use Category System: User Specification for Treated Wood

1.1.1.6 APA - THE ENGINEERED WOOD ASSOCIATION (APA)

a.	APA E30	Engineered Wood Construction Guide
b.	APA E445S	Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108)
c.	APA EWS R540C	Builder Tips Proper Storage and Handling of Glulam Beams
d.	APA EWS T300E	Technical Note: Glulam Connection Details
e.	APA F405L	Performance Rated Panels
f.	APA PS 1	Voluntary Product Standard for Structural Plywood
g.	APA PS 2	Voluntary Product Standard for Wood-Based Structural-Use Panels

1.1.1.7 ASME INTERNATIONAL (ASME)

a.	ASME B18.2.2	Square and Hex Nuts (Inch Series)
b.	ASME B18.52.1	Square and Hex Bolts and Screws Inch Series
c.	ASME B18.6.1	Wood Screws (Inch Series)

1.1.1.8 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
b.	ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
c.	ASTM A 687	Standard Specification for High-Strength Nonheaded Steel Bolts and Studs

d. ASTM C 1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
e. ASTM C 208	Cellulosic Fiber Insulating Board
f. ASTM C 79	Treated Core and Nontreated Core Gypsum Sheathing Board
g. ASTM D 1435	Standard Practice for Outdoor Weathering of Plastics
h. ASTM D 1972	Standard Practice for Generic Marking of Plastic Products
i. ASTM D 198	Standard Test Methods of Static Tests of Lumber in Structural Sizes
j. ASTM D 2898	Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
k. ASTM D 3498	Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
l. ASTM D 6007	Standard Test Method for Determining Formaldehyde Concentration in Air from Wood Products Using a Small Scale Chamber
m. ASTM D 6108	Standard Test Method for Compressive Properties of Plastic Lumber and Shapes
n. ASTM D 6109	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products
o. ASTM D 6111	Standard Test Method for Bulk Density and Specific Gravity of Plastic Lumber and Shapes by Displacement
p. ASTM D 6112	Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes
q. ASTM D 6117	Standard Test Methods for Mechanical Fasteners in Plastic Lumber and Shapes
r. ASTM D 6330	Standard Practice for Determination of Volatile Organic Compounds (Excluding Formaldehyde) Emissions from Wood-Based Panels Using Small Environmental Chambers Under Defined Test Conditions
s. ASTM D 6435	Standard Test Method for Shear Properties of Plastic Lumber and Plastic Lumber Shapes
t. ASTM D 696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
u. ASTM E 1333	Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber

v. ASTM E 96 — Standard Test Methods for Water Vapor Transmission of Materials

w. ASTM F 1667 — Driven Fasteners: Nails, Spikes, and Staples

x. ASTM F 547 — Nails for Use with Wood and Wood-Base Materials

1.1.1.9 COMPOSITE PANEL ASSOCIATION (CPA)

a. ANSI A208.2 — Medium Density Fiberboard (MDF) For Interior Applications

1.1.1.10 FM GLOBAL (FM)

a. FM DS 1-49 — Perimeter Flashing

1.1.1.11 GREEN SEAL (GS)

a. GS-36 — Commercial Adhesives

1.1.1.12 INTERNATIONAL CODE COUNCIL (ICC)

a. ICC IBC — International Building Code

1.1.1.13 REDWOOD INSPECTION SERVICE (RIS) OF THE CALIFORNIA REDWOOD ASSOCIATION (CRA)

a. RIS Grade Use — Redwood Lumber Grades and Uses

1.1.1.14 SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

a. SCAQMD Rule 1168 — Adhesive and Sealant Applications

1.1.1.15 TRUSS PLATE INSTITUTE (TPI)

a. TPI 1 — National Design Standard for Metal Plate Connected Wood Truss Construction; Commentary and Appendices

b. TPI BSCI — Guide to Good Practice for Handling, Installing, Restraining, and Bracing of Metal Plate Connected Wood Trusses

1.1.1.16 U.S. GENERAL SERVICES ADMINISTRATION (GSA)

a. CID A-A-1923 — Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)

b. CID A-A-1924 — Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors

c. CID A-A-1925 — Shield Expansion (Nail Anchors)

d. FS FF-B-588 — Bolt, Toggle: and Expansion Sleeve, Screw

e. FS FF-T-1813 (Basic) Tack

f. FS MM-T-371 Ties, Railroad, Wood (Cross and Switch)

g. FS UU-B-790 Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

1.1.1.17 U.S. GREEN BUILDING COUNCIL (USGBC)

a. LEED Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.1.1.18 WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

a. WCLIB 17 Standard Grading Rules

1.1.1.19 WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

a. WWPA G-5 Western Lumber Grading Rules

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Structural glued laminated members

b. Trussed rafters

c. Trussed joists

d. Fabricated structural members

e. Modifications of structural members

(1) Drawings of structural laminated members, fabricated wood trusses, engineered wood joists and rafters, and other fabricated structural members indicating materials, shop fabrication, and field erection details; including methods of fastening.

f. Nailers and Nailing Strips

(1) Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

1.2.1.2 SD-03 Product Data (To be used in creating LEED documentation notebook required at SD-11)

a. Local/Regional Materials; (LEED)

(1) Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

b. Salvaged Lumber; (LEED)
c. Recovered Lumber; (LEED)

(1) Documentation certifying products are from salvaged/recovered lumber sources. Indicate relative dollar value of salvaged content products to total dollar value of products included in project.

d. Underlayment; (LEED)

(1) Documentation needed indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project. Documentation indicating relative dollar value of rapidly renewable materials to total dollar value of products included in project. Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project. Where recycled lumber materials are used for structural applications, include lumber certification and quality grading.

e. Plastic Lumber; (LEED)
f. Fiberboard Wall Sheathing; (LEED)
g. Cellulose Honeycomb Panels; (LEED)

(1) Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project. Where recycled lumber materials are used for structural applications, include lumber certification and quality grading.

h. Fire-retardant treatment
i. Engineered wood products; (LEED)
j. Structural-use and OSB panels; (LEED)

(1) Submit documentation verifying that no urea-formaldehyde resins were used.

k. Oriented Strand Board; (LEED)

(1) Submit documentation indicating relative dollar value of rapidly renewable materials to total dollar value of products included in project.

l. Adhesives; (LEED)

(1) Submit manufacturer's product data, indicating VOC content.

1.2.1.3 SD-05 Design Data

a. Modifications of structural members;

(1) Design analysis and calculations showing design criteria used to accomplish the applicable analysis.

1.2.1.4 SD-06 Test Reports

a. Preservative-treated lumber and plywood

1.2.1.5 SD-07 Certificates

a. Certificates of grade

(1) Manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material not normally grade marked meet the specified requirements. Certificate of Inspection for grade marked material by an American Lumber Standards Committee (ALSC) recognized inspection agency prior to shipment.

b. Preservative treatment

1.2.1.6 SD-10 Operation and Maintenance Data

a. Plastic

(1) When not labeled, identify types in Operation and Maintenance Manual.

b. Take-back program

(1) Include contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.2.1.7 SD-11 Closeout Submittals – Prepare LEED documentation notebook containing information /documents in accordance with current LEED reference guide.

a. Local/Regional Materials; (LEED)

(1) Submit LEED documentation relative to local/regional materials credit in accordance with current LEED Reference Guide. Include in LEED Documentation Notebook.

b. Plastic Lumber; (LEED)
c. Fiberboard Wall Sheathing; (LEED)
d. Cellulose Honeycomb Panels; (LEED)

(1) Submit LEED documentation relative to recycled content credit in accordance with current LEED Reference Guide. Include in LEED Documentation Notebook.

e. Adhesives; (LEED)

(1) LEED documentation relative to low emitting materials credit in accordance with current LEED Reference Guide. Include in LEED Documentation Notebook.

f. Oriented Strand Board; (LEED)

(1) LEED documentation relative to rapidly renewable materials credit in accordance with current LEED Reference Guide. Include in LEED Documentation Notebook.

g. Engineered Wood Products; (LEED)

h. Structural-use and OSB Panels; (LEED)

(1) LEED documentation relative to low emitting materials credit in accordance with current LEED Reference Guide. Include in LEED Documentation Notebook.

i. Certified Wood; (LEED)

(1) LEED documentation relative to certified wood credit in accordance with current LEED Reference Guide. Include in LEED Documentation Notebook.

1.3 DELIVERY AND STORAGE

1.3.1 Deliver materials to the site in an undamaged condition. Store, protect, handle, and install prefabricated structural elements in accordance with manufacturer's instructions and as specified. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Store wood I-beams and glue-laminated beams and joists on edge. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. Laminated timber shall be handled and stored in accordance with AITC 111 or APA EWS R540C. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.4 GRADING AND MARKING

1.4.1 Lumber

1.4.1.1 Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Structural Glued Laminated Timber

1.4.2.1 Mark each member with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of structural glued laminated timber products. The marking shall indicate compliance with AITC A190.1 and shall include all identification information required by AITC A190.1. Structurally end-jointed lumber shall also be certified and grade marked in accordance with AITC A190.1.

1.4.3 Plywood

1.4.3.1 Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark shall identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with APA PS 1. Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

1.4.3.2 Structural-Use and OSB Panels

a. Mark each panel with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the panel. The mark shall indicate end use, span rating, and exposure durability classification and compliance with APA PS 2. Oriented Strand Board (OSB), APA F405L. Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

1.4.3.3 Preservative-Treated Lumber and Plywood

a. The Contractor shall be responsible for the quality of treated wood products. Each treated piece shall be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor shall provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.4.4 Fire-Retardant Treated Lumber

1.4.4.1 Mark each piece in accordance with AWPA M6, except pieces that are to be natural or transparent finished. In addition, exterior fire-retardant lumber shall be distinguished by a permanent penetrating blue stain. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWPA M6.

1.4.5 Hardboard, Gypsum Board, and Fiberboard

1.4.5.1 Mark each sheet or bundle to identify the standard under which the material is produced and the producer.

1.4.6 Plastic Lumber

1.4.6.1 Label plastic products to be incorporated into the project in accordance with ASTM D 1972, or provide product data indicating polymeric information in the Operation and Maintenance Manual.

a. Type 1: Polyethylene Terephthalate (PET, PETE).
b. Type 2: High Density Polyethylene (HDPE).
c. Type 3: Vinyl (Polyvinyl Chloride or PVC).
d. Type 4: Low Density Polyethylene (LDPE).
e. Type 5: Polypropylene (PP).
f. Type 6: Polystyrene (PS).
g. Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

1.5 SIZES AND SURFACING

1.5.1 ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber shall be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.6 MOISTURE CONTENT

1.6.1 Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products shall be as follows at the time of delivery to the job site:

1.6.1.1 Framing lumber and boards - 19 percent maximum

1.6.1.2 Timbers 5 inches and thicker - 23 percent maximum

1.6.1.3 Roof planking - 15 percent maximum

1.6.1.4 Materials other than lumber - Moisture content shall be in accordance with standard under which the product is produced

1.7 PRESERVATIVE TREATMENT

1.7.1 Treat wood products with waterborne wood preservatives conforming to AWPA P5. Pressure treatment of wood products shall conform to the requirements of AWPA U1 and AWPA T1. Pressure-treated wood products shall not contain arsenic, chromium, or other agents classified as carcinogenic, probably carcinogenic, or possibly carcinogenic to humans (compounds in Groups 1, 2A, or 2B) by the International Agency for Research on Cancer (IARC), Lyon, France. Pressure-treated wood products shall not exceed the limits of the U.S. EPA's Toxic Characteristic Leaching Procedure (TCLP), and shall not be classified as hazardous waste. Submit certification from treating plant stating chemicals and process used and net amount of preservatives retained are in conformance with specified standards. lumber and timber in accordance with AWPA C1 and AWPA C2, and plywood in accordance with AWPA C1 and AWPA C9. Treat structural glued laminated timber in accordance with AWPA C1 and AWPA C28.

1.7.1.1 0.25 pcf intended for above ground use.

1.7.1.2 0.40 pcf intended for ground contact and fresh water use. 0.60 pcf intended for Ammoniacal Copper Quaternary Compound (ACQ)-treated foundations. 0.80 to 1.00 pcf intended for ACQ-treated pilings. All wood shall be air or kiln dried after treatment. Specific treatments shall be verified by the report of an approved independent inspection agency, or the AWPA Quality Mark on each piece. Do not incise surfaces of lumber that will be exposed. Minimize cutting and avoid breathing sawdust. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution. Plastic lumber shall not be preservative treated. The following items shall be preservative treated:

a. Wood framing, woodwork, and plywood up to and including the subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are 24 inches or less from the earth underneath.

b. Wood members that are in contact with water.

c. Exterior wood steps, platforms, and railings; and all wood framing of open, roofed structures.

d. Wood sills, soles, plates, furring, and sleepers that are less than 24 inches from the ground, furring and nailers that are set into or in contact with concrete or masonry.

e. Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.7.2 Existing Structures

1.7.2.1 Use borate, permathrin, or a sodium silicate wood mineralization process to treat wood. Use borate for interior applications only.

1.7.3 New Construction

1.7.3.1 Use a boron-based preservative conforming to AWPA P18, sodium silicate wood mineralization process, or Ammoniacal Copper Quaternary Compound to treat wood. Use boron-based preservatives for above-ground applications only.

1.8 FIRE-RETARDANT TREATMENT

1.8.1 Fire-retardant treated wood shall be pressure treated in accordance with AWPA C20 for lumber and AWPA C27 for plywood. Material use shall be defined in AWPA C20 and AWPA C27 for Interior Type A and B and Exterior Type with fire retardants conforming to AWPA P17. Fire retardant treatment of wood products shall conform to the requirements of AWPA U1, Commodity Specification H and AWPA T1, Section 8.8. Treatment and performance inspection shall be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D 2898 prior to being tested. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, shall receive exterior fire-retardant treatment. Fire-retardant-treated wood products shall be free of halogens, sulfates, ammonium phosphate, and formaldehyde.

1.9 QUALITY ASSURANCE

1.9.1 Drawing Requirements

1.9.1.1 For fabricated structural members, trusses, glu-lam members, indicate materials, details of construction, methods of fastening, and erection details. Include reference to design criteria used and manufacturers design calculations. Submit drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

1.9.2 Data Required

1.9.2.1 Submit calculations and drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

1.9.3 Certificates of Grade

1.9.3.1 Submit certificates attesting that products meet the grade requirements specified in lieu of grade markings where appearance is important and grade marks will deface material.

1.9.4 Humidity Requirements

1.9.4.1 Sequence work to minimize use of temporary HVAC to dry out building and control humidity.

1.9.5 Plastic Lumber Performance

1.9.5.1 Plastic lumber intended for use in exterior applications shall have no fading or discoloration and no change in dimensional stability as tested in accordance with ASTM D 1435 for a period of 1 year.

1.10 ENVIRONMENTAL REQUIREMENTS

1.10.1 During and immediately after installation of treated wood, engineered wood products, and laminated wood products at interior spaces, provide temporary ventilation.

1.11 SUSTAINABLE DESIGN REQUIREMENTS

1.11.1 Local/Regional Materials

1.11.1.1 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources. Wood and materials may be locally available.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Virgin Lumber

2.1.1.1 Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations.

2.1.2 Salvaged Lumber

2.1.2.1 Provide salvaged lumber where specified. Unless otherwise noted, salvaged lumber shall be delivered clean, denailed, and free of paint, finish materials, and other contamination.

2.1.3 Recovered Lumber

2.1.3.1 Use recovered lumber where practical. Unless otherwise noted, recovered lumber shall be delivered clean and free of contamination. Provide grading certificates for any recovered wood materials used in structural applications.

2.1.4 Engineered Wood Products

2.1.4.1 Products shall contain no added urea-formaldehyde. Determine formaldehyde concentrations in air from engineered wood products under test conditions of temperature and relative humidity in accordance with ASTM D 6007 or ASTM E 1333. Determine Volatile Organic Compounds (VOCs), excluding formaldehyde, emitted from manufactured wood-based panels in accordance with ASTM D 6330.

2.1.5 Natural Decay- and Insect-Resistant Wood

2.1.5.1 Naturally durable wood shall be salvaged where specified. An occasional piece with corner sapwood shall be permitted if 90 percent or more of the width of each side on which the sapwood occurs is heartwood.

2.1.6 Plastic Lumber

2.1.6.1 HDPE lumber shall contain a minimum of 75 percent recycled content, with a minimum of 25 percent post-consumer recycled content. Mixed plastics and cellulose lumber shall contain a minimum of 100 percent recycled content, with a minimum of 50 percent post-consumer

recycled content. HDPE/fiberglass lumber shall contain a minimum of 95 percent recycled content with a minimum of 75 percent post-consumer recycled content. Other mixed resin lumber shall contain a minimum of 95 percent recycled content with a minimum of 50 percent post-consumer recycled content.

2.1.6.2 Shear Parallel to Length

a. Maximum 1,000 psi in accordance with ASTM D 6435.

2.1.6.3 Density

a. ASTM D 6111.

2.1.6.4 Compressive Strength

a. Secant Modulus: Minimum 70,000 psi in accordance with ASTM D 6108.

b. Stress at 3% strain: Minimum 1,500 psi in accordance with ASTM D 6108.

c. Compression Parallel to Grain: Minimum 3,000 psi in accordance with ASTM D 6112.

d. Compression Perpendicular to Grain: Minimum 1,000 psi in accordance with ASTM D 6112.

2.1.6.5 Flexural Strength

a. Minimum 2,000 psi in accordance with ASTM D 6109.

2.1.6.6 Tensile Strength

a. Minimum 1,250 psi in accordance with ASTM D 198.

2.1.6.7 Coefficient of Thermal Expansion

a. Maximum 0.000080 in/in/degree F in accordance with ASTM D 696.

2.1.6.8 Screw Withdrawal

a. 350 lbs in accordance with ASTM D 6117.

2.1.6.9 Nail Withdrawal

a. 150 lbs in accordance with ASTM D 6117.

2.2 LUMBER

2.2.1 Structural Lumber

2.2.1.1 Lumber grades and species shall be as indicated on the drawings.

2.2.2 Structural Glued Laminated Timber

2.2.2.1 Shall comply with AITC A190.1, properties shall be as indicated on the contract drawings.

2.2.2.2 Fabricated with wet-use adhesives. Unless otherwise indicated on the drawings, members shall be Architectural Appearance Grade, sealed with a penetrating sealer, and bundle wrapped as standard with the manufacturer and approved. Members shall be complete with hardware for joining laminated members and for their connection to other construction.

2.3 PLYWOOD, STRUCTURAL-USE, AND ORIENTED STRAND BOARD (OSB) PANELS

2.3.1 APA PS 1, APA PS 2, APA E445S, and APA F405L respectively.

2.3.1.1 Subflooring

a. Plywood

(1) C-D Grade, Exposure 1 durability classification, Span rating per contract drawings.

b. Structural-Use and OSB Panels

(1) Sheathing grade with durability equivalent to Exposure 1, Span Rating per contract drawings. OSB, APA E445S, Rated Stud-I-Floor.

2.3.1.2 Combination Subfloor-Underlayment

a. Plywood

(1) Underlayment Grade, Tongue and Grooved, Exposure 1, C-C Plugged. Minimum thickness shall be 23/32 inch, unless otherwise indicated on the drawings.

b. Structural-Use Panel

(1) Combination subfloor-underlayment grade with durability equivalent to Interior plywood with Exterior glue (Exposure 1), APA rated Stud–I–Floor, tongue and grooved, span rating as per contract drawings.

2.3.2 Wall Sheathing

2.3.2.1 Plywood

(1) C-D Grade, Exposure 1, and a minimum thickness of 1/2 inch , except where indicated to have greater thickness.

2.3.2.2 Structural-Use and OSB Panels

(1) Sheathing grade with durability equivalent to Exposure 1, Span Rating of 24/0 or greater. OSB, APA Rated Sheathing. OSB shall be a phenolic-glued, low-formaldehyde board.

2.3.3 Roof Sheathing

2.3.3.1 Plywood

a. C-D Grade, Exposure 1, Span Rating per contract drawings.

2.3.3.2 Structural-Use Panel

a. Sheathing grade with durability equivalent to Exposure 1, Span Rating per contract drawings.

2.3.4 Diaphragms

2.3.4.1 Plywood

a. Sheathing grade, Exposure 1, and a minimum thickness of 23/32 inch at floors and 15/32 inch at roofs, unless otherwise indicated on the drawings.

2.3.4.2 Structural-Use and OSB Panels

a. Sheathing grade with durability equivalent to Exposure 1 and a minimum thickness of 23/32 inch at floors and 15/32 inch at roofs, unless otherwise indicated on the drawings inch.

2.3.5 Shear Walls

2.3.5.1 Plywood

a. Sheathing grade, Exposure 1, and a minimum thickness of 23/32 inch at floors and 15/32 inch at roofs, unless otherwise indicated on the drawings.

2.3.5.2 Structural-Use and OSB Panels

a. Sheathing grade with durability equivalent to Exposure 1 and a minimum thickness of 23/32 inch at floors and 15/32 inch at roofs, unless otherwise indicated on the drawings inch.

2.4 UNDERLAYMENT

2.4.1 Underlayment shall conform to one of the following:

2.4.1.1 Hardboard

a. ANSI A135.4 service class, sanded one side, 1/4 inch thick, 4 feet wide.

2.4.1.2 Particleboard

a. ANSI A208.1, Grade 1-M-1, 1/4 inch thick, 4 x 4 feet. Compressed straw wood fibers with polymeric methylene diisocyanate (PMDI) resin binder.

2.4.1.3 Plywood

a. Plywood shall conform to APA PS 1, underlayment grade with exterior glue, or C-C (Plugged) exterior grade 11/32 inch thick, 4 feet wide.

2.4.1.4 Oriented Strand Board

a. OSB underlayment grade 0.225 inch.

2.4.1.5 Fiberboard

a. Use structural fiberboard, minimum 80 percent recycled newspaper or gypsum fiberboard, minimum 15 percent post-consumer newspaper or agrifiber particleboard or formaldehyde-free particleboard or MDF. Submit data indicating formaldehyde content.

2.4.1.6 Strawboard Panels

a. Minimum 70 percent agricultural waste straw with no added formaldehyde binders. Submit data indicating formaldehyde content.

2.4.1.7 Cork

a. Minimum 5 percent post-consumer recycled content or minimum 20 percent post-industrial recycled content. Minimum 85 percent biobased content.

2.5 OTHER MATERIALS

2.5.1 Hardboard Underlayment

2.5.1.1 ANSI A135.4, service class, sanded on one side, 1/4 inch thick 4 feet wide.

2.5.2 Fiberboard Wall Sheathing

2.5.2.1 ASTM C 208, 4 feet wide by 1/2 inch thick for supports 16 inches o.c. Sheathing shall be asphalt impregnated or asphalt coated to render the sheathing water resistant but vapor permeable. Non-structural fiberboard shall contain a minimum of 80 percent post-consumer recycled content. This item may contain post-consumer or post-industrial recycled content.

2.5.3 Foil-Faced Insulative Sheathing

2.5.3.1 Wood fiber core, chemically treated for water resistance, with aluminum foil laminated under pressure to both sides with water-resistant adhesive; 48 inches or 48 3/4 inches wide; 0.078 inch thick when used with corner bracing, 0.115 inch thick with studs up to 16 inches) o.c. without corner bracing, or 0.137 inch thick with studs up to 24 inches o.c. without corner bracing. The sheathing and installation shall have been accepted by ICBO as conforming to ICC IBC. The sheathing alone shall have a thermal resistance value (R value) of not less than 0.20.

2.5.4 Cellulose Honeycomb Panels

2.5.4.1 ASTM C 208. Panels shall be made of fire retardant paper and shall be impregnated with phenolic resins for moisture resistance. This item may contain post-consumer or post-industrial recycled content.

2.5.5 Building Paper

2.5.5.1 FS UU-B-790, Type I, Grade D, Style 1.

2.5.6 Trussed Rafters

2.5.6.1 Metal plate connected trusses designed, fabricated, and erected in accordance with TPI 1 and TPI BCSI.

2.5.7 Trussed Joists

2.5.7.1 Metal plate connected parallel chord wood trusses designed and fabricated in accordance with TPI 1.

2.5.8 Roof Decking

2.5.8.1 Unless otherwise indicated on the drawings, roof decking shall be commercial grade with minimum design value of 1100 psi in bending. Decking shall be a minimum of 2 inches thick with single tongue and groove; V-jointed, matched and dressed. As an option, fabricated laminated lumber decking with interlocking tongue and groove joints may be provided.

2.5.9 Miscellaneous Wood Members

2.5.9.1 Nonstress Graded Members

a. Members shall include bridging, corner bracing, furring, grounds, and nailing strips. Sizes shall be as follows unless otherwise shown:

Member	Size (inch)
Bridging	1 x 3 or 1 x 4 for use between members 2 x 12 and smaller; 2 x 4 for use between members larger than 2 x 12.
Corner bracing	1 x 4.
Furring	1 x 3.
Grounds	Plaster thickness by 1-1/2.
Nailing strips	1 x 3 or 1 x 4 when used as shingle base or interior finish, otherwise 2 inch stock.

2.5.9.2 Wood Bumpers

a. FS MM-T-371, Type I, Form A or B, and shall be oak.

2.5.9.3 Sill Plates

a. Sill plates shall be standard or number 2 grade.

2.5.9.4 Blocking

a. Blocking shall be standard or number 2 grade.

2.5.9.5 Rough Bucks and Frames

a. Rough bucks and frames shall be straight standard or number 2 grade.

2.5.10 Adhesives

2.5.10.1 Comply with applicable regulations regarding toxic and hazardous materials, GS-36 and SCAQMD Rule 1168, and as specified. Use water-based adhesives with maximum VOC content of 15 grams/liter for all interior applications. Interior adhesives, sealants, primers and sealants used as filler must meet the requirements of LEED low emitting materials credit.

2.6 ROUGH HARDWARE

2.6.1 Unless otherwise indicated or specified, rough hardware shall be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials shall be as recommended by the product manufacturer unless otherwise indicated or specified. Fasteners may contain post-consumer or post-industrial recycled content. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs shall be zinc-coated. Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather shall be copper alloy.

2.6.2 Bolts, Nuts, Studs, and Rivets

2.6.2.1 ASME B18.52.1, ASME B18.2.2, and ASTM A 687.

2.6.3 Anchor Bolts

2.6.3.1 ASTM A 307, size as indicated, complete with nuts and washers.

2.6.4 Expansion Shields

2.6.4.1 CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices shall be 3/8 inch.

2.6.5 Lag Screws and Lag Bolts

2.6.5.1 ASME B18.52.1.

2.6.6 Toggle Bolts

2.6.6.1 FS FF-B-588.

2.6.7 Wood Screws

2.6.7.1 ASME B18.6.1.

2.6.8 Nails and Staples

2.6.8.1 ASTM F 547, size and type best suited for purpose; staples shall be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails shall be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in AF&PA T10. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AF&PA T101. Reasonable judgment backed by experience shall ensure that the designed connection will not

cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

2.6.9 Wire Nails

2.6.9.1 ASTM F 1667.

2.6.10 Tacks

2.6.10.1 FS FF-T-1813.

2.6.11 Timber Connectors

2.6.11.1 Unless otherwise specified, timber connectors shall be in accordance with TPI 1, APA EWS T300E or AITC OT-01.

2.6.12 Clip Angles

2.6.12.1 Steel, size as indicated on the drawings.

2.6.13 Joist Hangers

2.6.13.1 Steel or iron, zinc coated, size as indicated on the drawings. Provide stainless steel hangers where required.

2.6.14 Tie Straps

2.6.14.1 For joists supported by the lower flange of steel beams, provide 1/8 by 1 1/2 inch steel strap, 2 feet long, except as indicated otherwise.

2.6.15 Joist Anchors

2.6.15.1 For joists supported by masonry walls, provide anchors 3/16 by 1 1/2 inch steel tee or strap, bent and of length to provide 4 inches embedment into wall and 12 inches along joist except as indicated otherwise. For joists parallel to masonry or concrete walls, provide anchors 1/4 by 1 1/4 inch minimum cross-sectional area, steel strap, length as necessary to extend over top of first three joists and into wall 8 inches, and with wall end of bend or pin type, except as indicated otherwise.

2.6.16 Door Buck Anchors

2.6.16.1 Metal anchors, 1/8 by 1 1/4 inch steel, 12 inches long, with ends bent 2 inches, except as indicated otherwise. Anchors shall be screwed to the backs of bucks and built into masonry or concrete. Locate 8 inches above sills and below heads and not more than 24 inches intermediately between. Anchorage of bucks to steel framing shall be as indicated.

2.6.17 Metal Bridging

2.6.17.1 Where not indicated or specified otherwise, No. 16 U.S. Standard gage, cadmium-plated or zinc-coated.

2.6.18 Toothed Rings and Shear Plates

2.6.18.1 AF&PA T101.

2.6.19 Beam Anchors

2.6.19.1 Steel U-shaped strap anchors 1/4 inch thick by 1 1/2 inches wide, except as indicated otherwise.

2.6.20 Metal Framing Anchors

2.6.20.1 Construct anchors to the configuration shown using hot dip zinc-coated steel conforming to ASTM A 653. Galvanizing level shall be as recommended by the manufacturer for the specific use. Provide stainless steel anchors where required. Except where otherwise shown, steel shall be not lighter than 18 gage. Special nails supplied by the manufacturer shall be used for all nailing.

2.6.21 Panel Edge Clips

2.6.21.1 Extruded aluminum or galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.

2.7 AIR INFILTRATION BARRIER

2.7.1 Air infiltration barrier shall be building paper meeting the requirements of ASTM C 1136, Type IV, style optional or a tear and puncture resistant olefin building wrap (polyethylene or polypropylene) with a moisture vapor transmission rate of 125 g per square meter per 24 hours in accordance with ASTM E 96, Desiccant Method at 23 degrees C or with a moisture vapor transmission rate of 670 g per square meter per 24 hours in accordance with ASTM E 96, Water Method at 23 degrees C.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Conform to AF&PA T10 and install in accordance with the National Association of Home Builders (NAHB) Advanced Framing Techniques: Optimum Value Engineering, unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Space plastic lumber boards as necessary to allow for lengthwise expansion and contraction. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Frame members for the passage of pipes, conduits, and ducts. Provide adequate support as appropriate to the application, climate, and modulus of elasticity of the product. Do not cut or bore structural members for the passage of ducts or pipes without approval. Reinforce all members damaged by such cutting or boring by means of specially formed and approved sheet metal or bar steel shapes, or remove and provide new, as approved. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise shall be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts shall be drawn up tight. Install plastic lumber with screws or bolts; if nails are used, use ring shank or spiral shank nails. Timber connections and fastenings shall conform to AF&PA T101. Provide 2 inch minimum clearance between chimneys and wood framing; provide 4 inch minimum clearance at fireplaces. Fill the spaces with strips of approved noncombustible material. Use slate or steel shims when leveling joists, beams, and girders on masonry or concrete. Do not use shimming on wood or metal bearings. When joists, beams, and girders are placed on masonry or concrete, a wood base plate shall be positioned and leveled with grout. The

joist, beam, or girder shall then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket shall be formed into the wall. The joist, beam, or girder shall then be placed into the pocket and leveled with a steel shim.

3.1.2 Sills

3.1.2.1 Set sills level and square and wedge with steel or slate shims; point or grout with non-shrinking cement mortar to provide continuous and solid bearing. Anchor sills to the foundations as indicated. Where sizes and spacing of anchor bolts are not indicated, provide not less than 5/8 inch diameter bolts at all corners and splices and space at a maximum of 6 feet o.c. between corner bolts. Provide at least two bolts for each sill member. Lap and splice sills at corners and bolt through the laps or butt the ends and through-bolt not more than 6 inches from the ends. Provide bolts with plate washers and nuts. Bolts in exterior walls shall be zinc-coated.

3.1.2.2 Anchors in Masonry

a. Embed anchor bolts not less than 15 inches in masonry unit walls and provide each with a nut and a 2 inch diameter washer at bottom end. Fully grout bolts with mortar, except where indicated otherwise.

3.1.2.3 Anchors in Concrete

a. Except where indicated otherwise, embed anchor bolts not less than 8 inches in poured concrete walls and provide each with a nut and a 2 inch diameter washer at bottom end.

3.1.3 Beams and Girders

3.1.3.1 Set beams and girders level and in alignment and anchor to bearing walls, piers, or supports with U-shaped steel strap anchors. Embed anchors in concrete or masonry at each bearing and through-bolt to the beams or girders with not less than two bolts. Provide bolts not less than 1/2 inch in diameter and with plate washers under heads and nuts. Install beams and girders not indicated otherwise with 8 inch minimum end bearing on walls or supports. Install beams and girders into walls with 1/2 inch clearance at the top, end, and sides. Provide joints and splices over bearings only and bolt or spike together.

3.1.4 Roof Framing or Rafters

3.1.4.1 Tops of supports or rafters shall form a true plane. Valley, ridge, and hip members shall be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters and nominally 2 inches thick. Rafters shall have full and solid bearing on plates. Valleys, hips, and ridges shall be straight and true intersections of roof planes. Necessary crickets and watersheds shall be formed. Rafters, except hip and valley rafters, shall be spiked to wall plate and to ceiling joists with no less than three 8-penny nails, unless otherwise indicated on the drawings. Rafters shall be toe-nailed to ridge, valley, or hip members with at least three 8-penny nails, unless otherwise noted on the drawings. Rafters shall be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters shall be secured to wall plates by mechanical connectors. Trussed rafters shall be installed in accordance with TPI BCSI. Engineered wood joists shall be installed in accordance with distributor's instructions.

3.1.5 Joists

3.1.5.1 Provide joists of the sizes and spacing indicated, accurately and in alignment, and of uniform width. Joists shall have full bearing on sills, plates, beams, girders, and trusses; provide laps

over bearing only and spike. Where joists are of insufficient length to produce a 12 inch lap, butt joists over bearing and provide wood scabs 2 nominal inches thick by depth of joists by 24 inches long or metal straps 1/4 by 1 1/2 inch by not less than 18 inches long nailed to each joist with not less than four 10-penny nails, or approved sheet metal connectors installed in accordance with the manufacturer's recommendations. Provide joists built into masonry with a beveled fire cut so that the top of the joist does not enter the wall more than one inch. Provide metal hangers for joists framing into the side of headers, beams, or girders. When a portion of the joist extends above the top flange of a steel beam or girder, provide a 3/8 inch space between the top flange and the extended portion of the joists to allow for shrinkage of joists. Joists built into concrete or masonry shall have a 1/2 inch minimum clearance at the top, end, and sides. For joists approved to be bored for the passage of pipes or conduits, bore through the neutral axis of the joist.

3.1.5.2 Floor (Ceiling) Framing

a. Except where otherwise indicated, joists shall have bearings not less than 4 inches on concrete or masonry and 1-1/2 inches on wood or metal. Joists, trimmers, headers, and beams framing into carrying members at the same relative levels shall be carried on joist hangers. Joists shall be lapped and spiked together at bearings or butted end-to-end with scab ties at joint and spiked to plates. Openings in floors shall be framed with headers and trimmers. Headers carrying more than two tail joists and trimmers supporting headers carrying more than one tail joist shall be doubled, unless otherwise indicated. Joists built into masonry shall be provided with a beveled fire cut so that the top of the joist does not enter the wall more than 1 inch. Engineered wood joists shall be installed in accordance with distributor's instructions.

3.1.5.3 Doubled Joists

a. Unless otherwise indicated on the drawings, provide under partitions running parallel with the floor joists, around stairways, chimneys, fireplaces, and at other openings where joists are cut and framed. Double, space for clearance, block apart 4 feet on center, rigidly frame, and spike together joists under partitions that are to receive ducts, pipes, and conduits.

3.1.5.4 Tie Straps

a. For joists supported by the lower flange of steel beams, provide straps at every fourth joist and the corresponding fourth joist on the opposite side. Tie joists across the top of the steel beam with a steel strap. Form straps to lie flat across the top of the beam and twist at the ends to provide flat contact with the side of each joist. Nail each strap at each end with three 10-penny nails spaced 2 inches o.c.

3.1.5.5 Joist Anchors

a. Unless otherwise indicated on the drawings, provide anchors for each fourth joist supported by a masonry wall. Build wall end of anchors into the wall. Nail anchor to the joist with three 10-penny nails spaced 2 inches o.c. Anchor the first three joists parallel to concrete or masonry walls at bridging points, but not less than 8 feet o.c. from end walls. Let anchors into the tops of each joist and spike to the top of joist with one 10-penny nail. Extend anchors at least 8 inches into the wall.

3.1.6 Bridging

3.1.6.1 Provide bridging for floor and ceiling joists and for roof rafters having slopes of less than 1/3. Locate bridging as indicated and as specified herein. Provide bridging for spans greater than 6

feet, but do not exceed 8 feet maximum spacing between rows of bridging. Install rows of bridging uniformly. Provide metal or wood cross-bridging, except where solid bridging is indicated. Do not nail the bottom end of cross-bridging until the subfloor has been laid.

3.1.6.2 Wood Cross-Bridging

a. Provide wood cross-bridging not less than 1 by 3nominal size. Nail wood cross-bridging at each end with two 8-penny nails for one by thick material.

3.1.6.3 Metal Cross-Bridging

a. Shall be the manufacturer's standard product, not less than 16 gage before forming and coating. Metal bridging shall be the compression type, lodged into or nailed to the wide faces of opposite joists at points diagonally across from each other near the bottoms and tops of joists.

3.1.7 Subflooring

3.1.7.1 Plywood, Structural-Use, and OSB Panels

a. Apply best side up with the grain of outer plies or the long dimension at right angles to joists. Stagger end joints and locate over the centerline of joists. Panel edges shall be T&G or supported by 2 by 4 members framed between joists so the edge joints of subfloor-underlayment occur over the centerline of blocking. Allow 1/8 inch spacing at panel ends and 1/4 inch at panel edges. Panels shall be continuous over two or more spans. Unless otherwise indicated on the drawings, nail panels 6 inches o.c. at supported edges and 10 inches o.c. over intermediate bearing. Nails shall be 8-penny common or 6-penny threaded. Provide at least 1/2 inch clearance between subflooring and masonry or concrete walls. Subflooring may be installed with adhesive conforming to ASTM D 3498 and nails spaced at 12 inches on center unless otherwise shown.

3.1.7.2 Combination Subfloor-Underlayment

a. Apply with the grain of the face plies or the long dimension at right angles to joists. Panels shall be continuous over two or more spans. Stagger end joints of adjacent panels. Panel edges shall be T&G or supported by 2 by 4 members framed between joists so the edge joints of subfloor-underlayment occur over the centerline of blocking. Place end joints of panels over the centerline of joists. Allow 1/8 inch spacing between panel edge and end joints. Unless otherwise indicated on the drawings, nail panels 6 inches o.c. at ends and edges and 10 inches o.c. along intermediate bearings unless they are glue-nailed in accordance with APA E30. Nails shall be 8-penny coated common or 6-penny threaded. Provide at least 1/2 inch clearance between subfloor-underlayment and masonry or concrete walls.

3.1.7.3 Depressed Subfloors

a. Provide depressed subfloors to receive ceramic and quarry tile floors. Nail cleats or ledgers of one by four material to the sides of joists to support the flooring material. Place the cleats at a depth below the top of the joists sufficient to allow the installation of the subflooring below the tops of joists. Snugly fit subflooring as specified herein between joists.

3.1.8 Underlayment

3.1.8.1 Install underlayment over subfloor just prior to laying of resilient flooring and protect from water and physical damage. Underlayment shall be hardboard, particleboard, plywood, or

OSB. Stagger end joints of underlayment with respect to each other, and stagger all joints with respect to paralleling panel joints in subfloor. Space panels 1/16 inch apart at ends and 1/8 inch apart at edges and at least 1/2 inch from concrete or masonry walls. Nail panels 6 inches o.c. along edges and 6 inches o.c. each way throughout panel, but not closer than 3/8 inch to panel edges. Nails shall be 4-penny annular ring or screw type and shall be countersunk 1/16 inch.

3.1.9 Columns and Posts

3.1.9.1 Set columns and posts, plumb, in alignment, and with full and uniform bearing. Do not embed the bottom and bearing surfaces of posts and columns in concrete or set in direct contact with concrete slabs on grade. Provide post and beam construction with steel post caps in such a manner that the post above will tier directly over the one below; fabricate the assembly in a rigid and substantial manner using bolts or lag screws.

3.1.10 Wall Framing

3.1.10.1 Studs

a. Select studs for straightness and set plumb, true, and in alignment. In walls and partitions more than eight feet tall, provide horizontal bridging at not more than 8 feet o.c. using nominal 2 inch material of the same width as the studs; install the bridging flat. Sizes and spacing of studs shall be as indicated. Double studs are required at jambs and heads of openings and triple at corners to form corner posts, unless otherwise indicated on the drawings. Frame corner posts to receive sheathing, lath, and interior finish. Toe-nail studs to sills or sole plates with four 8-penny nails or fasten with metal nailing clips or connectors. Anchor studs abutting concrete or masonry walls thereto near the top and bottom and at midheight of each story using expansion bolts or powder-actuated drive studs.

3.1.10.2 Plates

a. Use plates for walls and partitions of the same width as the studs to form continuous horizontal ties. Splice single plates; stagger the ends of double plates. Double top plates are required in walls and bearing partitions, built up of two nominal 2 inch thick members. Top plates for nonbearing partitions shall be single or double plates of the same size as the studs. Nail lower members of double top plates and single top plates to each stud and corner post with two 16-penny nails. Nail the upper members of double plates to the lower members with 10-penny nails, two near each end, and stagger 16 inches o.c. intermediately between. Nail sole plates on wood construction through the subfloor to each joist and header; stagger nails. Anchor sole plates on concrete with expansion bolts, one near each end and at not more than 6 feet o.c., or with powder-actuated fasteners, one near each end and at not more than 3 feet o.c., unless otherwise indicated on the drawings. Provide plates cut for the passage of pipes or ducts with a steel angle as a tie for the plate and bearing for joist.

3.1.10.3 Firestops

a. Provide firestops for wood framed walls and partitions and for furred spaces of concrete or masonry walls at each floor level and at the ceiling line in the top story. Where firestops are not automatically provided by the framing system used, they shall be formed of closely fitted wood blocks of nominal 2 inch thick material of the same width as the studs or joists. Lightweight concrete units may be used at the first-floor level to serve jointly as firestopping and ratproofing.

3.1.10.4 Diagonal Bracing

a. Unless an engineered lateral bracing system is shown on the drawings, provide diagonal bracing at all external corners and internal angles and at maximum 40 foot centers in stud walls. Bracing may be omitted where wood sheathing, plywood or structural-use panel sheathing, 4 by 8 foot fiberboard sheathing, or gypsum board sheathing is used. Bracing shall be of 1 by 6 material, let into the exterior face of studs. Extend bracing from top plates to sill at an angle of approximately 45 degrees and double nail at each stud. When openings occur near corners, provide diagonal knee braces extending from the corner post above headers to top plates and from below window sills to the main sill. Nail bracing is required at each bearing with two 8-penny nails.

3.1.11 Wall Sheathing

3.1.11.1 Plywood, Structural-Use, and OSB Panel Wall Sheathing

a. Apply horizontally or vertically. Extend sheathing over and nail to sill and top plate. Abut sheathing edges over centerlines of supports. Allow 1/8 inch spacing between panels and 1/8 inch at windows and doors. If sheathing is applied horizontally, stagger vertical end joints. Unless otherwise indicated on the drawings, nail panels with 6-penny nails spaced 6 inches o.c. along edges of the panel and 12 inches o.c. over intermediate supports. Keep nails 3/8 inches away from panel ledges. Provide 2 by 4 blocking for horizontal edges not otherwise supported.

3.1.11.2 Fiberboard Wall Sheathing

a. Apply fiberboard wall sheathing allowing a 1/8 inch joint at edges to permit expansion, except at frames and openings where sheathing shall be fitted snugly. Pre-expand sheathing before application, allowing sheathing to condition for humidity as recommended by the sheathing manufacturer. Provide 2 by 4 blocking for horizontal edges not otherwise supported.

(1) Fiberboard wall sheathing used with diagonal-braced framing shall be either 2 or 4 feet wide. Sheathing 2 feet wide shall have T&G or shiplapped edges and shall be applied horizontally with vertical joints staggered. Apply sheathing with tongued edge up and nail at edges and intermediate bearings with 1 3/4 inch long, zinc-coated steel roofing nails spaced on maximum 4 1/2 inch centers. Apply sheathing 4 feet wide either horizontally or vertically. Nail sheathing with 1 3/4 inch long, zinc-coated steel roofing nails spaced 4 inches maximum o.c. at edges and 8 inches maximum o.c. at intermediate bearings.

3.1.11.3 Gypsum Sheathing Board

a. Apply gypsum sheathing board either horizontally or vertically. Butt joints and locate over the centerlines of supports. Horizontally applied sheathing shall be T&G, applied with tongued edge up. Stagger vertical joints and abut sheet closely to frames of openings. Unless otherwise indicated on the drawings, nail sheathing with 11 gage, 3/8 inch head, zinc-coated nails 1 1/2 inches long for 1/2 inch sheathing and 1 3/4 inches long for 5/8 inch sheathing, spaced 3/8 inch minimum from edges. Provide 2 by 4 blocking for horizontal edges of 4 foot wide panels not otherwise supported.

(1) Gypsum Sheathing Board Used with Diagonal-Braced Framing: Sheathing shall be either 2 or 4 feet wide. Apply sheathing 2 feet wide horizontally. Nail 4 inches maximum o.c. at edges and over intermediate bearings. Apply sheathing 4 feet wide either horizontally or vertically. Nail 4 inches maximum o.c. at edges and 8 inches maximum o.c. at intermediate bearings.

(2) Gypsum Sheathing Board Used with Unbraced Frames: Sheathing shall be 4 feet wide and applied vertically. Extend sheathing over and nail to both sill and top plates. Unless otherwise indicated on the drawings, nail 4 inches maximum o.c. at edges and 8 inches maximum o.c. at intermediate bearings.

3.1.11.4 Foil-Faced Insulative Sheathing

a. Apply sheathing vertically. Butt or overlap joints and locate over centerline of supports. Attach sheathing to framing with 1 1/4 inch, large, flat-head, 11 gage, galvanized roofing nails or 16 gage, 7/16 inch minimum crown, galvanized staples with 1 1/4 inch legs. For nonstructural application (with corner bracing), space fasteners 6 inches o.c. on all panel edges and 12 inches o.c. on intermediate supports, regardless of sheathing thickness, for studs not more than 24 inches o.c. For structural application (without corner bracing), for studs not more than 16 inches o.c., space fasteners 3 inches o.c. on all edges and 6 inches o.c. on intermediate members using minimum 0.115 inch thickness; for studs up to 24 inches o.c., space fasteners 3 inches o.c. on all edges and 3 inches o.c. on intermediate supports using minimum 0.137 inch thickness, unless otherwise indicated on the drawings.

3.1.11.5 Particleboard

a. Install according to manufacturer's instructions and accepted industry standards.

3.1.11.6 Cellulose Honeycomb Panels

a. Install according to manufacturer's instructions and accepted industry standards.

3.1.12 Wood Sheathing

3.1.12.1 Sheathing end joints shall be made over framing members and so alternated that there will be at least two boards between joints on the same support. Each board shall bear on at least three supports. Boards shall be nailed at each support using two nails for boards 6 inches and less in width and three nails for boards more than 6 inches in width. Roof sheathing shall not be installed where roof decking is installed.

3.1.13 Building Paper

3.1.13.1 Provide building paper where indicated. Apply paper shingle fashion, horizontally, beginning at the bottom of the wall. Lap edges 4 inches, and nail with one inch, zinc-coated roofing nails, spaced 12 inches o.c. and driven through tin discs.

3.1.14 Ceiling Joists

3.1.14.1 Size joists as indicated and set accurately and in alignment. Toe-nail joists to all plates with not less than three 10-penny nails. Frame openings in ceilings with headers and trimmers.

3.1.15 Metal Framing Anchors

3.1.15.1 Provide framing anchors at every rafter or trussed rafter to fasten rafter or trussed rafter to plates and studs against uplift movement and forces as indicated. Anchors shall be punched and formed for nailing so that nails will be stressed in shear only. Nails shall be zinc-coated; drive a nail in each nail hole provided in the anchor.

3.1.16 Trusses

3.1.16.1 Metal plate connected wood trusses shall be handled, erected, and braced in accordance with TPI BCSI and as indicated.

3.1.17 Structural Glued Laminated Timber Members

3.1.17.1 Brace members before erection. Align members and complete all connections before removal of bracing. Unwrap individually wrapped members only after adequate protection by a roof or other cover has been provided. Treat scratches and abrasions of factory applied sealer with two brush coats of the same sealer used at the factory.

3.1.18 Plywood and Structural-Use Panel Roof Sheathing

3.1.18.1 Install with the grain of the outer plies or long dimension at right angles to supports. Stagger end joints and locate over the centerlines of supports. Allow 1/8 inch spacing at panel ends and 1/4 inch at panel edges. Unless otherwise indicated on the drawings, nail panels with 8-penny common nails or 6-penny annular rings or screw-type nails spaced 6 inches o.c. at supported edges and 12 inches o.c. at intermediate bearings. Do not use staples in roof sheathing. Where the support spacing exceeds the maximum span for an unsupported edge, provide adequate blocking, tongue-and-groove edges, or panel edge clips, in accordance with APA E30.

3.1.19 Stair Framing

3.1.19.1 Cut carriages to exact shape required to receive treads and risers, with risers of uniform height and treads of uniform width. Provide trimmers, nailers, and blocking as required to support finish materials.

3.1.20 Plastic Lumber

3.1.20.1 In conjunction with above requirements, follow manufacturer's recommendations for plastic lumber installation, including requirements for structural support, thermal movement, working, fastening, and finishing. Use standard woodworking tools, including carbide tips, coarse saw blades, and routers with aggressive cutters. Follow manufacturer's recommendations for repair by melting.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

3.2.1.1 Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.2 Roof Nailing Strips

3.2.2.1 Provide roof nailing strips for roof decks as indicated. Apply nailing strips in straight parallel rows in the direction and spacing indicated. Strips shall be surface applied.

a. Surface-Applied Nailers: Shall be 3 inches wide and of thickness to finish flush with the top of the insulation. Anchor strips securely to the roof deck with powder actuated fastening devices or expansion shields and bolts, spaced not more than 24 inches o.c. On decks with slopes of one inch or more, provide surface applied wood nailers for securing insulation and for nailing of roofing felts.

b. Embedded Nailers: Shall be nominal 2 by 3 with 2 inch sides beveled. Set and anchor nailers to finish flush with the roof deck surface.

3.2.3 Roof Edge Strips and Nailers

3.2.3.1 Provide at perimeter of roof, around openings through roof, and where roofs abut walls, curbs, and other vertical surfaces. Except where indicated otherwise, nailers shall be 6 inches wide and the same thickness as the insulation. Anchor nailers securely to underlying construction. Anchor perimeter nailers in accordance with FM DS 1-49. Strips shall be grooved for edge venting; install at walls, curbs, and other vertical surfaces with a 1/4 to 1/2 inch air space.

3.2.4 Crickets, Cants, and Curbs

3.2.4.1 Provide wood saddles or crickets, cant strips, curbs for scuttles and ventilators, and wood nailers bolted to tops of concrete or masonry curbs and at expansion joints, as indicated, specified, or necessary.

3.2.5 Rough Wood Bucks

3.2.5.1 2 inch nominal thickness. Set wood bucks true and plumb. Anchor bucks to concrete or masonry with steel straps extending into the wall 8 inches minimum. Place anchors near the top and bottom of the buck and space uniformly at 2 foot maximum intervals.

3.2.6 Wood Blocking

3.2.6.1 Provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.2.7 Wood Grounds

3.2.7.1 Provide for fastening wood trim, finish materials, and other items to plastered walls and ceilings. Install grounds in proper alignment and true with an 8 foot straightedge.

3.2.8 Wood Furring

3.2.8.1 Provide where shown and as necessary for facing materials specified. Except as shown otherwise, furring strips shall be nominal one by 3, continuous, and spaced 16 inches o.c. Erect furring vertically or horizontally as necessary. Nail furring strips to masonry. Do not use wood plugs. Provide furring strips around openings, behind bases, and at angles and corners. Furring shall be plumb, rigid, and level and shall be shimmed as necessary to provide a true, even plane with surfaces suitable to receive the finish required. Form furring for cornices, offsets, and breaks in walls or ceilings on 1 by 4 wood strips spaced 16 inches o.c.

3.2.9 Wood Bumpers

3.2.9.1 Dress to the sizes indicated, and bevel edges. Bore, countersink, and bolt bumpers in place.

3.2.10 Temporary Closures

3.2.10.1 Provide with hinged doors and padlocks and install during construction at exterior doorways and other ground level openings that are not otherwise closed. Cover windows and other unprotected openings with polyethylene or other approved material, stretched on wood frames. Provide dustproof barrier partitions to isolate areas as directed.

3.2.11 Temporary Centering, Bracing, and Shoring

3.2.11.1 Provide for the support and protection of masonry work during construction as specified in Section 04 20 00. Forms and centering for cast-in-place concrete work are specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.12 Wood Sleepers

3.2.12.1 Run wood sleepers in lengths as long as practicable and stagger end joints in adjacent rows. Sleepers for gymnasium floors are specified in Section entitled "Gymnasium-Type Hardwood Strip Flooring Systems."

3.2.13 Diaphragms

3.2.13.1 Install plywood, structural-use, or OSB panels with the long dimension perpendicular to supports. End joints shall be continuous staggered]and located over the centerline of supports. Unless otherwise indicated on the drawings, nail panels with 8-penny nails spaced not more than 6 inches on centers around the diaphragm boundaries and along continuous panel edges, and 6 inches on centers at all other supported edges and 12 inches o.c. over intermediate bearings.

3.2.14 Shear Walls

3.2.14.1 Install plywood or structural-use panels with long dimension parallel or perpendicular to supports. Provide blocking behind edges not located over supports. Unless otherwise indicated on the drawings, nail panels with 8-penny nails spaced not more than 6 inches on centers along panel edges and 6 inches o.c. over intermediate bearings.

3.2.15 Bridging

3.2.15.1 Wood bridging shall have ends accurately bevel-cut to afford firm contact and shall be nailed at each end with two nails. Metal bridging shall be installed as recommended by the manufacturer. The lower ends of bridging shall be driven up tight and secured after subflooring or roof sheathing has been laid and partition framing installed.

3.2.16 Corner Bracing

3.2.16.1 Corner bracing shall be installed when required by type of sheathing used or when siding, other than panel siding, is applied directly to studs. Corner bracing shall be let into the exterior surfaces of the studs at an angle of approximately 45 degrees, shall extend completely over wall plates, and shall be secured at each bearing with two nails.

3.2.17 Sill Plates

3.2.17.1 Sill plates shall be set level and square and anchor bolted at not more than 6 feet on centers and not more than 12 inches from end of each piece. A minimum of two anchors shall be used for each piece.

3.3 INSTALLATION OF TIMBER CONNECTORS

3.3.1 Installation of timber connectors shall conform to applicable requirements of AF&PA T101.

3.4 ERECTION TOLERANCES

3.4.1 Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

3.4.1.1 Layout of walls and partitions: 1/4 inch from intended position;

3.4.1.2 Plates and runners: 1/4 inch in 8 feet from a straight line;

3.4.1.3 Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

3.4.1.4 Face of framing members: 1/4 inch in 8 feet from a true plane.

a. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

(1) Layout of walls and partitions: 1/4 inch from intended position;

(2) Plates and runners: 1/8 inch in 8 feet from a straight line;

(3) Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/8 in 8 feet from a true plane.

3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

3.5.1 Provide special inspections and testing for seismic-resisting systems as indicated on the drawings.

3.6 WASTE MANAGEMENT

3.6.1 In accordance with the Waste Management Plan and as specified or otherwise noted. Separate and reuse scrap sheet materials larger than 2 square feet, framing members larger than 16 inches, and multiple offcuts of any size larger than 12 inches. Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

3.6.2 Separate composite wood from other wood types and recycle or reuse. Coordinate with selected manufacturer for take-back program and submit manufacturer's policy statement on program. Set aside scrap and plastic lumber and return to manufacturer for recycling into new product. When such a service is not available, local recyclers shall be sought after to reclaim the materials. Fold up metal banding, flatten, and recycle.

3.6.3 Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations. Do not leave any wood,

shavings, sawdust, or other wood waste buried in fill or on the ground. Prevent sawdust and wood shavings from entering the storm drainage system.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN HARDBOARD ASSOCIATION (AHA)

a. AHA A135.6 Hardboard Siding

1.1.1.2 AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

a. ALSC PS 20 American Softwood Lumber Standard

1.1.1.3 AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

a. AWPA C1 All Timber Products - Preservative Treatment by Pressure Processes

b. AWPA C2 Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes

c. AWPA C20 Structural Lumber Fire-Retardant Treatment by Pressure Processes

d. AWPA C27 Plywood - Fire-Retardant Treatment by Pressure Processes

e. AWPA C9 Plywood - Preservative Treatment by Pressure Processes

f. AWPA M2 Standard for Inspection of Treated Wood Products

g. AWPA M4 Standard for the Care of Preservative-Treated Wood Products

1.1.1.4 APA - THE ENGINEERED WOOD ASSOCIATION (APA)

a. APA PS 1 Voluntary Product Standard for Construction and Industrial Plywood

b. APA PS 2 Voluntary Product Standard for Wood-Based Structural-Use Panels

1.1.1.5 ARCHITECTURAL WOODWORK INSTITUTE (AWI)

a. AWI Qual Stds AWI Quality Standards

1.1.1.6 ASME INTERNATIONAL (ASME)

a. ASME B18.2.2 Square and Hex Nuts (Inch Series)

b. ASME B18.52.1 Square and Hex Bolts and Screws Inch Series

c. ASME B18.6.1 Wood Screws (Inch Series)

1.1.1.7 ASTM INTERNATIONAL (ASTM)

a. ASTM A 687 — Standard Specification for High-Strength Nonheaded Steel Bolts and Studs

b. ASTM D 2898 — Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing

c. ASTM F 547 — Nails for Use with Wood and Wood-Base Materials

1.1.1.8 BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

a. BHMA A156.9 — Cabinet Hardware

1.1.1.9 COMPOSITE PANEL ASSOCIATION (CPA)

a. CPA A208.1 — Medium Density Fiberboard (MDF) For Interior Applications

1.1.1.10 HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

a. HPVA HP-1 — American National Standard for Hardwood and Decorative Plywood

1.1.1.11 NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

a. NEMA LD 3 — Standard for High-Pressure Decorative Laminates

1.1.1.12 NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

a. NHLA Rules — Rules for the Measurement & Inspection of Hardwood & Cypress

1.1.1.13 NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

a. NELMA Grading Rules — Standard Grading Rules for Northeastern Lumber

1.1.1.14 REDWOOD INSPECTION SERVICE (RIS) OF THE CALIFORNIA REDWOOD ASSOCIATION (CRA)

a. RIS Grade Use — Redwood Lumber Grades and Uses

1.1.1.15 SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

a. SCMA Spec — Standard Specifications for Grades of Southern Cypress

1.1.1.16 SOUTHERN PINE INSPECTION BUREAU (SPIB)

a. SPIB 1003 — Standard Grading Rules for Southern Pine Lumber

1.1.1.17 U.S. DEPARTMENT OF COMMERCE (DOC)

a. PS-58 — Basic Hardboard

1.1.1.18 WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

a. WCLIB 17 — Standard Grading Rules

1.1.1.19 WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

a. WWPA G-5 — Western Lumber Grading Rules

1.1.1.20 WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

a. WDMA I.S. 4 Water-Repellent Preservative Non-Pressure Treatment for Millwork

1.1.1.21 WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)

a. WMMPA WM 6 Industry Standard for Non-Pressure Treating of Wood Millwork

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Detail Drawings

1.2.1.2 SD-03 Product Data

a. Siding

b. Epoxy-Aggregate Panels

(1) Manufacturer's printed data, showing texture, density, catalog cuts, and installation instructions.

c. Wood Items, Siding, and Trim

(1) Manufacturer's printed data indicating the usage of engineered or recycled wood products, and environmentally safe preservatives.

1.2.1.3 SD-04 Samples

a. Siding

b. Wood Shingles

c. Moldings

d. Fascias and Trim

(1) Samples shall be of sufficient size to show patterns, color ranges, and types, as applicable, of the material proposed to be used.

1.2.1.4 SD-07 Certificates

a. Certificates of grade

b. Certificates of compliance

1.3 DETAIL DRAWINGS

1.3.1 The Contractor shall submit detail drawings showing fabricated items and special mill and woodwork items. Drawings shall indicate materials and details of construction, methods of fastening, erection, and installation.

1.4 CERTIFICATES

1.4.1 Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

1.4.2 Provide certificates of compliance unless materials bear certification markings or statements.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Deliver lumber, plywood, trim, and millwork to job site in an undamaged condition. Stack materials to ensure ventilation and drainage. Protect against dampness before and after delivery. Store materials under cover in a well-ventilated enclosure and protect against extreme changes in temperature and humidity. Do not store products in building until wet trade materials are dry.

1.6 QUALITY ASSURANCE

1.6.1 Lumber

1.6.1.1 Identify each piece or each bundle of lumber, millwork, and trim by the grade mark of a recognized association or independent inspection agency that is certified by the Board of Review, American Lumber Standards Committee, to grade the species.

1.6.2 Plywood

1.6.2.1 Each sheet of plywood shall bear the mark of a recognized association or independent inspection agency that maintains continuing control over quality of the plywood. Mark shall identify plywood by species group or span rating, and shall show exposure durability classification, grade, and compliance with APA PS 1.

1.6.3 Hardboard and Particleboard

1.6.3.1 Materials shall bear a marking or statement identifying the producer and the applicable standard.

1.6.3.2 Particleboard not allowed in Dyess AFB construction.

1.6.4 Pressure-Treated Lumber and Plywood

1.6.4.1 Each treated piece shall be inspected in accordance with AWPA M2.

1.6.5 Nonpressure-Treated Woodwork and Millwork

1.6.5.1 Mark, stamp, or label, indicating compliance with WDMA I.S. 4.

1.6.6 Fire-Retardant Treated Lumber

1.6.6.1 Each piece to bear Underwriters Laboratories label or the label of another nationally recognized independent testing laboratory.

PART 2 PRODUCTS

2.1 WOOD

2.1.1 Sizes and Patterns of Wood Products

2.1.1.1 Yard and board lumber sizes shall conform to ALSC PS 20. Provide shaped lumber and millwork in the patterns indicated and standard patterns of the association covering the species. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the applicable standard.

2.1.2 Trim, Finish, and Frames

2.1.2.1 Provide species and grades listed for materials to be paint finished. Provide materials that are to be stain, natural, or transparent finished one grade higher than that listed. Provide species indicated for materials to be transparent finished. Run trim, except window stools and aprons with hollow backs.

a. TABLE OF GRADES FOR WOOD TO RECEIVE PAINT FINISH

Grading Rules	Exterior and Interior Species	Trim, Finish, and Frames
WWPA G-5 grading rules	Aspen Douglas Fir-Larch Douglas Fir-South Engelmann Spruce -Lodgepole Pine Engelmann Spruce Hem-Fir Idaho White Pine Lodgepole Pine Mountain Hemlock Mountain Hemlock -Hem-Fir Ponderosa Pine- Sugar Pine (Ponderosa Pine -Lodgepole Pine) White Woods (Western Woods) Western Cedars Western Hemlock	All Species: C & Btr. Select (Choice & Btr Idaho White Pine) or Superior Finish. Western Red Cedar may be graded C & Btr. Select or A & Btr. per Special Western Red Cedar Rules.
WCLIB 17 standard grading rules	Douglas Fir-Larch Hem-Fir Mountain Hemlock Sitka Spruce Western Cedars Western Hemlock	All Species: C & Btr VG, except A for Western Red Cedar

SPIB 1003 grading rules	Southern Pine	C & Btr
SCMA Spec Standard specification	Cypress	C-Select
NELMA Grading Rules standard grading rules	Balsam Fir Eastern Hemlock- Tamarack Eastern Spruce Eastern White Pine Norway Pine Northern Pine Northern White Cedar	All Species: C- Select except C & Btr for Eastern White Pine and Norway Pine
RIS Grade Use standard specifications	Redwood	Clear Clear All Heart
NHLA Rules rules	Cypress Red Gum Soft Elm Birch	B Finish Select or Btr (for interior use only)

2.1.3 Utility Shelving

2.1.3.1 Utility shelving shall be a suitable species equal to or exceeding requirements of No. 3 Common white fir under WWPA G-5, 1 inch thick; or plywood, interior type, Grade A-B, 3/4 inch thick, any species group.

2.1.4 Softwood Plywood

2.1.4.1 APA PS 1, thicknesses as indicated.

a. Plywood for Soffits: Exterior type, B-B medium density overlay.

b. Plywood for Shelving: Interior type, A-B Grade, any species group.

c. Plywood for Countertops: Exterior type, A-C Grade.

2.1.5 Hardwood Plywood

2.1.5.1 HPVA HP-1, Type II or III, Premium (A), face veneers of species indicated.

2.1.6 Hardboard

2.1.6.1 PS-58, tempered type, thickness as indicated.

2.1.7 Particleboard

2.1.7.1 Not allowed in Dyess AFB work.

2.1.8 Stairs

2.1.8.1 Treads 1-1/4 inches thickness, clear red or white oak. Risers one inch nominal finish lumber.

2.1.9 Shoe Mold

2.1.9.1 Clear red or white oak, 1/2 by 5/8 inch unless otherwise indicated.

2.1.10 Wood Seats

2.1.10.1 Clear maple, oak, or other suitable hardwood, not less than 1-5/8 inches thick, with rounded edges. Provide stainless steel stanchions or brackets as indicated.

2.1.11 Wood Bumpers

2.1.11.1 Clear hardwood, species as indicated, dressed to size indicated and with outer edges beveled.

2.1.12 Siding

2.1.12.1 Horizontal siding shall be hardboard, plywood, or wood. Panel siding shall be hardboard or plywood.

2.1.13 Horizontal Hardboard Siding

2.1.13.1 AHA A135.6, factory primed face and longitudinal edges, factory sealed back, lap type, width as indicated, maximum practicable lengths, 3/8 or 7/16 inch thick, smooth or textured face as indicated.

2.1.14 Panel Hardboard Siding

2.1.14.1 AHA A135.6, factory primed face and longitudinal edges, factory sealed back, 4 feet wide, maximum practicable lengths, 3/8 or 7/16 inch thick, smooth or embossed face.

2.1.15 Horizontal Plywood Siding

2.1.15.1 APA PS 1, exterior, medium-density overlay lap type, width as indicated, maximum practicable lengths, 3/8 or 7/16 inch thick, texture as indicated.

2.1.16 Panel Plywood Siding

2.1.16.1 APA PS 1, exterior, 4 feet wide, maximum practicable lengths, span rating of 16 o.c., pattern and texture as selected from manufacturer's standards.

2.1.17 Wood Siding

2.1.17.1 Species and grades listed in paragraph entitled "Trim, Finish, and Frames" Table. Siding shall be type and style indicated, one inch thick, width as indicated, and maximum practicable lengths, smooth or rough-sawn texture.

2.1.18 Wood Structural Panels

2.1.18.1 Wood Structural Panels shall conform to APA PS 2, exterior, exposure 1, single-faced, 4 feet

wide, maximum practicable lengths, selected from manufacturer's standard patterns to satisfy the wind load for the specified span.

2.1.19 Epoxy-Aggregate Panels

2.1.19.1 Prefinished epoxy-aggregate panels shall consist of an asbestos-free cement board base sheet with a factory applied surface of epoxy resins and decorative natural stone chips. Factory applied finish shall be a minimum of 20 mils of 100 percent solids, two-component epoxy resin-based coating followed by an application of inert aggregate. Stone color shall be selected from manufacturer's standard colors. Cement board base sheet shall be a minimum of 1/4 inch thick. Finished panels shall be dimensionally stable. Water absorption on the surfaced side shall not exceed 0.20 percent after 24 hours of submergence in water. Accessories shall be manufacturer's standard extruded matching color aluminum moldings. Moldings shall be provided for meeting strips, end caps, inside corners, or outside corners. Fasteners shall be noncorrosive, self-tapping screw type and finished to match the color of stone. Caulking compound shall be color compatible, low modulus silicone or urethane type.

2.2 SOFFITS

2.2.1 Hardboard and Plywood

2.2.1.1 Hardboard and plywood soffits shall be siding grade hardboard, 3/8 or 7/16 inch thick; plywood, APA PS 1, exterior type, Grade A-C, 11/32 inch thick for 24 inch on centers maximum span with all edges supported.

2.3 FASCIAS AND TRIM

2.3.1 Wood

2.3.1.1 Fascias and trim, including exterior door and window casing, shall be species and grade listed in TABLE I of this section. Sizes shall be as indicated. Metal corners may be furnished in lieu of wood cornerboards for horizontal siding; and if furnished, shall be galvanized steel and primed or aluminum and primed.

2.4 WOOD SHINGLES

2.4.1 Wood shingles shall be No. 1 Grade, Red Cedar, Tidewater Red Cypress or California Redwood in accordance with applicable grading rules under which it is produced, random widths, 16 inches minimum length. Wood shingles shall be fire-retardant treated as indicated.

2.5 COUNTER TOPS

2.5.1 Laminated Plastic

2.5.1.1 NEMA LD 3.

a. Countertop Finish

(1) Grade GP 50 or PF 42, satin finish. Color and pattern shall be as indicated.

b. Backing Sheet

(1) BK 20.

2.5.2 Solid Surface

2.5.2.1 Manufactured from homogeneous solid sheets for filled plastic resin complying with materials and performance requirements of ANSI Z 124.3, for Type 5 or Type 6, without a precoated finish.

2.6 MOISTURE CONTENT OF WOOD PRODUCTS

2.6.1 Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery to the job site, and when installed, shall be as follows:

2.6.1.1 Interior Paneling: 6 percent.

2.6.1.2 Interior Finish Lumber, Trim, and Millwork 1-1/4 Inches Nominal or Less in Thickness: 6 percent on 85 percent of the pieces and 8 percent on remainder.

2.6.1.3 Exterior Treated and Untreated Finish Lumber and Trim 4 Inches Nominal or Less in Thickness: 19 percent.

2.6.1.4 Exterior Wood Siding: 15 percent.

2.6.1.5 Moisture content of other materials shall be in accordance with the applicable standards.

2.7 PRESERVATIVE TREATMENT OF WOOD PRODUCTS

2.7.1 Nonpressure Treatment

Treat woodwork and millwork, such as exterior trim, door trim, and window trim, in accordance with WDMA I.S. 4, with either 2 percent copper napthenate, 3 percent zinc napthenate, or 1.8 percent copper-8-quinolinolate. Provide a liberal brushcoat of preservative treatment to field cuts and holes.

2.7.2 Pressure Treatment

2.7.2.1 Lumber and plywood used on the exterior of buildings or in contact with masonry or concrete shall be treated with water-borne preservative listed in AWPA P5 in accordance with AWPA C1, AWPA C2, and AWPA C9, as applicable, and inspected in accordance with AWPA M2. Identify treatment on each piece of material by the quality mark of an agency accredited by the Board of Review of the American Lumber Standards Committee. Plywood shall be treated to a reflection level as follows:

a. Exterior wood molding and millwork within 18 inches of soil, in contact with water or concrete shall be preservative-treated in accordance with WMMPA WM 6.

b. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4.

c. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil.

2.8 FIRE-RETARDANT TREATMENT

2.8.1 Wood Products

2.8.1.1 Fire-retardant treated lumber shall be pressure treated in accordance with AWPA C20. Fire-retardant treated plywood shall be pressure treated in accordance with AWPA C27. Material use shall be defined in AWPA C20 and AWPA C27 for Interior Type A and B and Exterior Type. Treatment and performance inspection shall be by a qualified independent testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance with such rating. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D 2898, Method A, prior to being tested for compliance with AWPA C20 or AWPA C27.

2.9 HARDWARE

2.9.1 Provide sizes, types, and spacings of manufactured building materials recommended by the product manufacturer except as otherwise indicated or specified.

2.9.2 Wood Screws

2.9.2.1 ASME B18.6.1.

2.9.3 Bolts, Nuts, Lag Screws, and Studs

2.9.3.1 ASME B18.52.1, ASME B18.2.2, and ASTM A 687.

2.9.4 Nails

2.9.4.1 Nails shall be the size and type best suited for the purpose and shall conform to ASTM F 547. Nails shall be hot-dip galvanized or aluminum when used on exterior work. For siding, length of nails shall be sufficient to extend 1-1/2 inches into supports, including wood sheathing over framing. Screws for use where nailing is impractical shall be size best suited for purpose.

2.9.5 Vertical Slotted Shelf Standards

2.9.5.1 Heavy duty shelving with two rows of slots to receive heavy duty brackets.

2.9.6 Closet Hanger Rods

2.9.6.1 Chromium-plated steel rods, not less than one inch diameter by 18 gage. Rods may be adjustable with integral mounting brackets if smaller tube is one inch by 18 gage. Provide intermediate support bracket for rods more than 48 inches long.

2.10 FABRICATION

2.10.1 Quality Standards (QS)

2.10.1.1 The terms "Premium," "Custom," and "Economy" refer to the quality grades defined in AWI Qual Stds. Items not specified to be of a specific grade shall be Custom grade. The AWI QS is superseded by all contract document requirements indicated or stated herein.

2.10.2 Countertops

2.10.2.1 Fabricate with glued and screwed plywood to form an integral unit. Bond laminated plastic under pressure to exposed surfaces, using type of glue recommended by plastic manufacturer. Countertop unit shall be post-formed type with no-drip nose, cove moulding, and Style A back splash, and covered with NEMA LD 3, Grade PF 42 plastic. Back splash shall be 4 inches high.

2.10.3 Cabinets

2.10.3.1 Wall and base cabinets and vanity cabinets shall be of the same construction and appearances. Fabricate with solid ends and frame fronts, or with frames all around. Frames shall be solid hardwood not less than 3/4 by 1 1/2 inches. Ends, bottom, back, partitions, and doors shall be hardwood plywood. Mortise and tenon, dovetail, or dowel and glue joints to produce a rigid unit. Cover exposed edges of plywood with hardwood strips. Doors, frames, and solid exposed ends shall be 3/4 inch thick; bottom, partitions, and framed ends 1/2 inch minimum; shelves 5/8 inch minimum; back 1/4 inch minimum.

a. Cabinet Hardware

(1) BHMA A156.9. Provide hardware for each door, including two self-closing hinges. Provide two side-mounted metal drawer slides for each drawer. Hardware exposed to view shall be brushed chrome.

b. Finish

(1) Provide a natural factory finish on wood surfaces after fabrication. Finish shall be fabricator's standard natural finish, except that it shall be equivalent to one coat of sealer and one coat of spar varnish on all surfaces and a second coat of spar varnish on surfaces exposed to view. Sand lightly and wipe clean between coats.

2.10.4 Casework With Transparent Finish (CTF)

2.10.4.1 AWI Quality Grade (CTF)

(1) Custom grade unless indicated otherwise.

2.10.4.2 Construction (CTF)

(1) Details shall conform to flush overlay or exposed face frame design.

2.10.4.3 Exposed Parts

(1) Specie, and cut as indicated.

2.10.4.4 Semi-Exposed Parts

(1) As specified in the AWI Qual Stds for the grade selected.

2.10.5 Casework With High Pressure Laminate Finish (CHPL)

2.10.5.1 AWI Quality Grade (CHPL)

a. Custom grade unless indicated otherwise.

2.10.5.2 Construction (CHPL)

a. Details shall conform to flush overlay or exposed face frame design.

2.10.5.3 Exposed Surfaces

a. High pressure laminate, color, pattern as selected by C.O.

2.10.5.4 Semi-Exposed Surfaces

a. As specified in the AWI Qual Stds for the grade selected.

PART 3 EXECUTION

3.1 FINISH WORK

3.1.1 Provide sizes, materials, and designs as indicated and as specified. Apply primer to finish work before installing. Where practicable, shops assemble and finish items of built-up millwork. Joints shall be tight and constructed in a manner to conceal shrinkage. Miter trim and moldings at exterior angles and cope at interior angles and at returns. Material shall show no warp after installation. Install millwork and trim in maximum practical lengths. Fasten finish work with finish nails. Provide blind nailing where practicable. Set face nails for putty stopping.

3.1.2 Exterior Finish Work

3.1.2.1 Machine-sand exposed flat members and square edges. Machine-finish semi-exposed surfaces. Construct joints to exclude water. In addition to nailing, glue joints of built-up items with waterproof glue as necessary for weather-resistant construction. Provide well distributed end joints in built-up members. Provide shoulder joints in flat work. Hold backs of wide-faced miters together with metal rings and waterproof glue. Fascias and other flat members, unless otherwise indicated, shall be 3/4 inch thick. Provide door and window trim in single lengths. Provide braced, blocked, and rigidly anchored cornices for support and protection of vertical joints. Install soffits in largest practical size. Joints of plywood shall occur over center lines of supports. Fasten soffits with aluminum or stainless steel nails. Back prime all concealed surfaces of exterior trim.

3.1.3 Interior Finish Work

3.1.3.1 After installation, sand exposed surfaces smooth. Provide window and door trim in single lengths.

3.1.4 Door Frames

3.1.4.1 Set plumb and square. Provide solid blocking at not more than 16 inches o.c. for each jamb. Position blocking to occur behind hinges and lock strikes. Double wedge frames and fasten with finishing nails. Set nails for putty stopping.

3.1.5 Thresholds

3.1.5.1 Provide thresholds 5/8 inch thick by 2-5/8 inches wide with beveled sides and cut to fit at jambs. Fasten thresholds with casing nails. Set nails for putty stopping.

3.1.6 Window Stools and Aprons

3.1.6.1 Provide stools with rabbet over window sill. Provide aprons with returns cut accurately to profile of member.

3.1.7 Bases

3.1.7.1 Flat member with a molded top and shoe mold if indicated. Fasten base to framing or to grounds. Nail shoe mold to the base.

3.1.8 Finish Stair Work

3.1.8.1 Fit, nail, screw, bolt, and glue stair work together to form a strong rigid structure without squeaks or vibrations. Anchor newels and posts securely to rough stair framing. Cut newels, posts, and drops accurately around floor construction to make tight fit. Install balusters into treads and landings with glue. Install railing with straight runs following slope of stairs and with smooth curve turns. Return railing profile at ends and secure joints with bolts and nuts. Secure railing to posts and newels with concealed anchors. Support wall rails on metal brackets spaced near ends and not over 5 feet o.c.

3.2 SHELVING

3.2.1 One inch nominal thick wood shelf material or 3/4 inch thick plywood shelf material supported substantially with end and intermediate supports and arranged to prevent buckling and sagging. Provide cleats except where hook strips are specified or indicated. Where adjustable shelving is indicated, provide standards and brackets for each shelf. Anchor standards to wall at not more than 2 feet o.c.

3.2.2 Linen Closets

3.2.2.1 Unless indicated otherwise, linen closets shall have a counter shelf 20 inches wide located 36 inches above the floor, a lower shelf approximately 18 inches wide and 18 inches above the floor, and three upper shelves 11-1/4 inches wide located 14 inches above the counter shelf and 14 inches apart.

3.2.3 Storage Rooms

3.2.3.1 Provide storage rooms with shelves of size and arrangement as indicated.

3.2.4 Room Closets

3.2.4.1 Provide two shelves 11-1/4 inches wide. Support lower shelf by hook strips at back and ends, and provide full-length wood or metal clothes hanger rods unless indicated otherwise.

3.3 CLOTHES HANGER RODS

3.3.1 Provide clothes hanger rods where indicated and in closets having hook strips. Set rods parallel with front edges of shelves and support by sockets at each end and by intermediate brackets spaced not more than 4 feet o.c.

3.4 MISCELLANEOUS

3.4.1 Counters

3.4.1.1 Construct as indicated. Conceal fastenings where practicable, fit counter neatly, install in a rigid and substantial manner, and scribe to adjoining surfaces. Provide counter sections in longest lengths practicable; keep joints in tops to a minimum; and where joints are necessary, provide tight hairline joints drawn up with concealed-type heavy pull-up bolts. Glue joints with water-resistant glue and, in addition, make rigid and substantial with screws, bolts, or other approved fastenings.

3.4.2 Cabinets

3.4.2.1 Install level, plumb, and tight against adjacent walls. Secure cabinets to walls with concealed toggle bolts, and secure top to cabinet with concealed screws. Make cut-outs for fixtures to templates supplied by fixture manufacturer. Carefully locate cut-outs for pipes so that edges of holes will be covered by escutcheons.

3.4.3 Workbenches

3.4.3.1 Construct as indicated. Install level, plumb, and tight against adjacent construction. Fasten to walls with screws or toggle bolts and to floors with expansion bolts.

3.4.4 Wood Seats

3.4.4.1 Support seats as indicated. Secure seats to supports with screws or bolts as required; countersink heads and fill holes with hardwood filler, finished flush with tops of seats.

3.4.5 Wood Bumpers

3.4.5.1 Bore, countersink, and bolt in place where indicated.

3.5 SIDING

3.5.1 Installation of Siding

3.5.1 Fit and position without springing or otherwise forcing into place. For siding to have a stain finish, set nails and stop with nonstaining putty to match finished siding. For siding to have a paint finish, drive nails flush.

3.5.2 3.5.2 Horizontal Siding

3.5.2.1 Make end joints over framing members and alternate so at least two boards will be between joints on same support. Uniformly distribute shorter pieces throughout area. Provide starter strips to establish proper slant for siding. Predrill ends of siding if necessary to prevent splitting when nailed. Horizontal bevel or plain lap siding: Overlap and nail into each support in accordance with recommendations of siding manufacturer. Horizontal drop siding: Work each course into top edge of previous course. Nail into each support.

3.5.3 Vertical Board Siding

3.5.3.1 Apply siding with horizontal joints only at locations indicated. Work each board into edge of previous course. Nail into supports at 24 inches on center.

3.5.4 Vertical Board and Batten Siding

3.5.4.1 Apply with horizontal joints only at locations indicated. Install each board with 1/2 inch space between it and previous board. Nail at center of board and into supports at 24 inches on center. Center battens over space between boards and nail down center at 16 inches on center.

3.5.5 Panel Siding

3.5.5.1 Apply panels with edges at joints spaced in accordance with manufacturer's recommendations. Shiplapped edges or square edges covered with battens shall be sealed. Back all edges with framing members. Nail panels at edges 6 inches on center and at intermediate supports 12 inches on center. Edge nailing to be 3/8 inch from edges. For shiplap joints, nail 3/8 inch from visible joint and at a location to penetrate lap with previous panel. When panel siding is part of an engineered shear wall or used as wall-bracing, nail shiplap joints to supports with double rows of nails. Space battens at 16 inches on center and nail down center at 24 inches on center.

3.5.6 Epoxy-Aggregate Coated Panels

3.5.6.1 Panels shall be installed where shown. Installation shall be as recommended by the manufacturer of the panels.

3.6 SOFFITS

3.6.1 Wood

3.6.1.1 Panels shall be applied with edges at joints spaced in accordance with manufacturer's instructions and with all edges backed with framing members. Panels shall be nailed 3/8 inch from edges at 6 inches on center and at intermediate supports at 12 inches on center. Panels shall be installed using the maximum practical lengths.

3.7 FASCIAS AND EXTERIOR TRIM

3.7.1 Exposed surfaces and square edges shall be machine sanded, caulked, and constructed to exclude water. Joints of built-up items, in addition to nailing, shall be glued as necessary for weather-resistant construction. End joints in built-up members shall be well distributed. Joints in flat work shall be shouldered. Backs of wide-faced miters shall be held together with metal rings and glue. Fascias and other flat members shall be in maximum practicable lengths. Cornices shall be braced, blocked, and rigidly anchored for support and protection of vertical joints.

3.8 MOLDING AND INTERIOR TRIM

3.8.1 Molding and interior trim shall be installed straight, plumb, level and with closely fitted joints. Exposed surfaces shall be machine sanded at the mill. Molded work shall be coped at returns and interior angles and mitered at external corners. Intersections of flatwork shall be shouldered to ease any inherent changes in plane. Window and door trim shall be provided in single lengths. Blind nailing shall be used to the extent practicable, and face nailing shall be set and stopped with a nonstaining putty to match the finish applied. Screws shall be used for attachment to metal;

setting and stopping of screws shall be of the same quality as required where nails are used.

3.9 WOOD SHINGLES

3.9.1 Wood shingles shall be applied by single-coursing method and with a weather exposure of 7-1/2 inches. Each shingle shall be nailed with two nails 1 inch above butt line of the next course, except shingles more than 8 inches in width shall be nailed with three nails. Starter course shall be doubled, and vertical joints shall be offset from vertical joints of the previous course. Corners shall be mitered over flashing as indicated.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

a. ANSI A161.2 Decorative Laminate Countertops, Performance Standards for Fabricated High Pressure

1.1.1.2 ARCHITECTURAL WOODWORK INSTITUTE (AWI)

a. AWI Qual Stds AWI Quality Standards

1.1.1.3 ASTM INTERNATIONAL (ASTM)

a. ASTM D 1037 Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

b. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

c. ASTM F 547 Nails for Use with Wood and Wood-Base Materials

1.1.1.4 BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

a. BHMA A156.9 Cabinet Hardware

1.1.1.5 COMPOSITE PANEL ASSOCIATION (CPA)

a. CPA A208.1 Medium Density Fiberboard (MDF) For Interior Applications

b. CPA A208.2 Medium Density Fiberboard (MDF) for Interior Applications

1.1.1.6 NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

a. NEMA LD 3 Standard for High-Pressure Decorative Laminates

1.1.1.7 WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

a. WDMA I.S. 1-A Architectural Wood Flush Doors

1.2 GENERAL DESCRIPTION

1.2.1 Work in this section includes laminate clad custom casework as shown on the drawings and as described in this specification. This Section includes high-pressure laminate surfacing and cabinet hardware. All exposed and semi-exposed surfaces, whose finish is not otherwise noted on the drawings or finish schedule, shall be sanded smooth and shall receive a clear finish of polyurethane. Wood finish may be shop finished or field applied in accordance with Section 09 90 00 Paints and Coatings.

1.3 SUBMITTALS

1.3.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.3.1.1 SD-02 Shop Drawings

a. Shop Drawings

b. Installation

(1) Shop drawings showing all fabricated casework items in plan view, elevations and cross-sections to accurately indicate materials used, details of construction, dimensions, methods of fastening and erection, and installation methods proposed. Shop drawing casework items shall be clearly cross-referenced to casework items located on the project drawings. Shop drawings shall include a color schedule of all casework items to include all countertop, exposed, and semi-exposed cabinet finishes including finish material manufacturer, pattern, and color.

1.3.1.2 SD-03 Product Data

a. Wood Materials

b. Wood Finishes

c. Finish Schedule

(1) Descriptive data which provides narrative written verification of all types of construction materials and finishes, methods of construction, etc. not clearly illustrated on the submitted shop drawings. Data shall provide written verification of conformance with AWI Qual Stds for the quality indicated to include materials, tolerances, and types of construction. Both the manufacturer of materials and the fabricator shall submit available literature which describes re-cycled product content, operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

1.3.1.3 SD-04 Samples

a. Plastic Laminates

(1) Two samples of each plastic laminate pattern and color. Samples shall be a minimum of 5 by 7 inches in size.

b. Cabinet Hardware

(1) One sample of each cabinet hardware item specified.

1.3.1.4 SD-07 Certificates

a. Quality Assurance

b. Laminate Clad Casework

(1) A quality control statement which illustrates compliance with and understanding of AWI Qual Stds requirements, in general, and the specific AWI Qual Stds requirements provided in this specification. The quality control statement shall also certify a minimum of ten years Contractor's experience in laminate clad casework fabrication and construction. The

quality control statement shall provide a list of a minimum of five successfully completed projects of a similar scope, size, and complexity.

1.4 QUALITY ASSURANCE

1.4.1 Unless otherwise noted on the drawings, all materials, construction methods, and fabrication shall conform to and comply with the custom grade quality standards as outlined in AWI Qual Stds, Section 400G and Section 400B for laminate clad cabinets. These standards shall apply in lieu of omissions or specific requirements in this specification. Contractors and their personnel engaged in the work shall be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified. Contractor must demonstrate knowledge and understanding of AWI Qual Stds requirements for the quality grade indicated.

1.5 MOCK-UP

1.5.1 Prior to final approval of shop drawings, a full-size mock-up shall be provided of a typical cabinet. The mock-up shall include all components and hardware necessary to illustrate a completed unit and shall include a minimum of one door and one drawer assembly. The completed mock-up shall include countertops and back splashes where specified. The mock-up shall utilize specified finishes in the patterns and colors as indicated on the drawings or as selected. Upon disapproval, the Contractor shall rework or remake the mock-up until approval is secured. Rejected units shall be removed from the jobsite. Approved mock-up may remain as part of the finished work.

1.6 DELIVERY AND STORAGE

1.6.1 Casework may be delivered knockdown or fully assembled. All units shall be delivered to the site in undamaged condition, stored off the ground in fully enclosed areas, and protected from damage. The storage area shall be well ventilated and not subject to extreme changes in temperature or humidity.

1.7 SEQUENCING AND SCHEDULING

1.7.1 Work shall be coordinated with other trades. Units shall not be installed in any room or space until painting and ceiling installation are complete within the room where the units are located. Floor cabinets shall be installed before finished flooring materials are installed.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Field measurements shall be verified as indicated in the shop drawings before fabrication.

PART 2 PRODUCTS

2.1 WOOD MATERIALS

2.1.1 Lumber

2.1.1.1 All framing lumber shall be kiln-dried Grade III to dimensions as shown on the drawings.

Frame front, where indicated on the drawings, shall be nominal 3/4 inch hardwood.

2.1.1.2 Standing or running trim casework components which are specified to receive a transparent finish shall be plain sawn hardwood species, as indicated. AWI grade shall be custom. Location, shape, and dimensions shall be as indicated on the drawings.

2.1.2 Panel Products

2.1.2.1 Plywood

a. All plywood panels used for framing purposes shall be veneer core hardwood plywood, AWI Qual Stds Grade AA. Nominal thickness of plywood panels shall be as indicated in this specification and on the drawings.

2.1.2.2 Particleboard

a. Not allowed on Dyess AFB projects.

2.1.2.3 Medium Density Fiberboard

a. Medium density fiberboard (MDF) shall be an acceptable panel substrate where noted on the drawings or specifications. Medium density fiberboard shall meet the minimum standards listed in CPA A208.2.

2.2 SOLID POLYMER MATERIAL

2.2.1 Solid surfacing casework components shall conform to the requirements of Section 06 61 16 Solid Polymer (Solid Surfacing) Fabrications.

2.3 HIGH PRESSURE DECORATIVE LAMINATE (HPDL)

2.3.1 All plastic laminates shall meet the requirements of NEMA LD 3 and ANSI A161.2 for high-pressure decorative laminates. Design, colors, surface finish and texture, and locations shall be as indicated on the drawings or as selected. Plastic laminate types and nominal minimum thicknesses for casework components shall be as indicated in the following paragraphs.

2.3.1.1 Horizontal General Purpose Standard (HGS) Grade

a. Horizontal general purpose standard grade plastic laminate shall be 0.048 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where postforming is not required.

2.3.1.2 Vertical General Purpose Standard (VGS) Grade

a. Vertical general purpose standard grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of casework components where postforming is not required.

2.3.1.3 Horizontal General Purpose Postformable (HGP) Grade

a. Horizontal general purpose postformable grade plastic laminate shall be 0.042 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where post forming is required.

2.3.1.4 Vertical General Purpose Postformable (VGP) Grade

a. Vertical general purpose postformable grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of components where postforming is required for curved surfaces.

2.3.1.5 Horizontal General Purpose Fire Rated (HGF) Grade

a. Horizontal general purpose fire rated grade plastic laminate shall be 0.048 inches (plus or minus 0.005 inches) in thickness. Laminate grade shall have a class 1, class A fire rating in accordance with ASTM E 84.

2.3.1.6 Vertical General Purpose Fire Rated (VGF) Grade

a. Vertical general purpose fire rated grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade shall have a class 1, class A fire rating in accordance with ASTM E 84.

2.3.1.7 Cabinet Liner Standard (CLS) Grade

a. Cabinet liner standard grade plastic laminate shall be 0.020 inches in thickness. This laminate grade is intended for light duty semi-exposed interior surfaces of casework components.

2.3.1.8 Backing Sheet (BK) Grade

a. Undecorated backing sheet grade laminate is formulated specifically to be used on the backside of plastic laminated panel substrates to enhance dimensional stability of the substrate. Backing sheet thickness shall be 0.020 inches. Backing sheets shall be provided for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate.

2.4 THERMOSET DECORATIVE OVERLAYS (MELAMINE)

2.4.1 Thermoset decorative overlays (melamine panels) shall be used for all semi-exposed surfaces.

2.5 EDGE BANDING

2.5.1 Edge banding for casework doors and drawer fronts shall be PVC vinyl and shall be 0.125 inch thick. Material width shall be 15/16 inches. Color and pattern shall match exposed door and drawer front laminate pattern and color.

2.6 CABINET HARDWARE

a. Shelf Standards and Rests: Holes drilled at one inch centers with minimum four supports per shelf.
b. Drawer and Door Pulls: Provide Stanley 44831/2 in US26D brushed chrome, or equal.
c. Drawer Slides: Black zinc or epoxy finish all ball-bearing side mounted full extension slides with positive stop to prevent accidental drawer removal. Use minimum 75 pound capacity for drawers 32 inches wide or less and 100 capacity for drawers over 32 inches wide. Knape & Vogt, Accuride, Blum or approved equivalent.
d. Hinges: Stanley "Series 1500" or equivalent concealed hinges, 95 degree opening, self-closing, one pair each door under 36 inches tall, 1-1/2 pair each door 37-60 inches tall, 2 pair each door over 60 inches tall.
e. Cabinet Locks: Similar to Knape &Vogt "986 drawer lock" installed where indicated.

f. Felt Stops: Apply felt stops, two each drawer and two each door, with adhesive backing. Stops shall be same thickness as the thickness of vertical pivot, hinge or leaf.

2.7 FASTENERS

2.7.1 Nails, screws, and other suitable fasteners shall be the size and type best suited for the purpose and shall conform to ASTM F 547 where applicable.

2.8 ADHESIVES, CAULKS, AND SEALANTS

2.8.1 Adhesives

2.8.1.1 Adhesives shall be of a formula and type recommended by AWI. Adhesives shall be selected for their ability to provide a durable, permanent bond and shall take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance. Adhesives shall meet local regulations regarding VOC emissions and off-gassing.

a. Wood Joinery

(1) Adhesives used to bond wood members shall be a Type II for interior use. Adhesives shall withstand a bond test as described in WDMA I.S. 1-A.

b. Laminate Adhesive

(1) Adhesive used to join high-pressure decorative laminate to wood shall be adhesive consistent with AWI and laminate manufacturer's recommendations. PVC edge banding shall be adhered using a polymer-based hot melt glue.

c. Caulk

(1) Caulk used to fill voids and joints between laminated components and between laminated components and adjacent surfaces shall be clear, 100 percent silicone.

d. Sealant

(1) Sealant shall be of a type and composition recommended by the substrate manufacturer to provide a moisture barrier at sink cutouts and all other locations where unfinished substrate edges may be subjected to moisture.

2.9 WOOD FINISHES

2.9.1 Paint, stain, varnish and their applications required for laminate clad casework components shall be as indicated in Section 09 90 00 Paints And Coatings. Color and location shall be as indicated on the drawings or as selected.

2.10 ACCCESSORIES

2.10.1 Glass and Glazing

2.10.1.1 Glass required in laminated casework shall be referenced by type in accordance with Section 08 81 00 Glazing. Glass shall be one of the following:

a. Float or Patterned glass as indicated.

b. Safety glass: Clear; fully tempered or laminated 1/8 inches thick minimum.

c. Wire Glass: Clear, polished both sides; square mesh woven stainless steel wire grid 1/8 inches thick minimum.

2.10.2 Grommets

2.10.2.1 Grommets shall be plastic material for cutouts with a diameter of 2-1/2 inches. Locations shall be as indicated on the drawings.

2.11 FABRICATION

2.11.1 Fabrication and assembly of components shall be accomplished at the shop site to the maximum extent possible. Construction and fabrication of cabinets and their components shall meet or exceed the requirements for AWI custom grade unless otherwise indicated in this specification. Cabinet style, in accordance with AWI Qual Stds, Section 400-G descriptions, shall be flush overlay or as indicated on the drawings.

2.11.1.1 Base and Wall Cabinet Case Body. All components receiving plastic laminate shall be Grade A faced plywood.

a. Cabinets Components:
   (1) Ends, Divisions, Bottoms and Tops: Hardwood plywood, 3/4 inch thick minimum.
   (2) Rails: Hardwood lumber, 3/4 inch thick minimum.
   (3) Shelves:
      (a) Exposed - Hardwood plywood.
      (b) Semi-exposed - Hardwood plywood.
      (c) Concealed - Softwood plywood.
      (d) Thickness: 3/4 inch for spans up to 36 inches; 1 inch for spans up to 48 inches.
   (4) Backs: Hardboard or veneer core plywood, 1/4 inch thick.
   (5) Drawer Sides, Backs and Subfronts: 1/2 inch thick solid lumber or microlam plywood.
   (6) Drawer Bottoms: Hardboard or veneer core plywood, 1/4 inch thick.
   (7) Drawer Fronts: Hardwood lumber or edged hardwood plywood, 3/4 inch thick. If using hardwood lumber, joined pieces will not be permitted.
   (8) Hinged Cabinet Doors:
      (a) Flat Panel Doors: Hardwood plywood with matching edge banding; 3/4 inch thick for doors up to 30 inches wide by 60 inches high; 1 to 1-1/4 inch thick for doors up to 36 inches wide by 72 inches high or:
      (b) Style and Rail: construct with 3” nominal width hardwood edges and hardwood plywood flat panel.
   (9) Tops: BC or better plywood 1-1/2 inch top.
b. Drawer Construction: Custom grade.
c. Joinery and Fastening of Case Body Members: Premium or custom grade.
d. Seal all edges of backsplash and sinks with matching sealant.
e. Provide grommets for accessing outlets inside cabinets.
f. Provide electrical extension rings as required for outlets inside cabinets to be “flush” with cabinet back finish.

2.11.1.2 Cabinet Floor Base

a. Floor cabinets shall be mounted on a base constructed of 3/4 inch plywood or 3/4 inch veneer

core exterior plywood. Base assembly components shall be a moisture-resistant panel product. Finished height for each cabinet base shall be not less than the full height of the installed, specified wall base. Bottom edge of the cabinet door or drawer face shall [be flush with top of base.

2.11.1.3 Shelving

a. General Requirements

(1) Shelving shall be fabricated from 3/4 inch plywood. All shelving top and bottom surfaces shall be finished with thermoset decorative overlay (melamine). Shelf edges shall be finished in PVC edge banding.

b. Shelf Support System

(1) The shelf support system shall be:

(a) Pin Hole Method. Holes shall be drilled on the interior surface of the cabinet side walls. Holes shall be evenly spaced in two vertical columns. The holes in each column shall be spaced at 1 inch increments starting 6 inches from the cabinet interior bottom and extending to within 6 inches of the top interior surface of the cabinet. Holes shall be drilled to provide a level, stable surface when the shelf is resting on the shelf pins. Hole diameter shall be coordinated with pin insert size to provide a firm, tight fit.

2.11.1.4 Laminate Clad Countertops

a. Laminate countertop substrate shall be constructed of 3/4 inch Grade A faced plywood. The substrate shall be moisture-resistant where countertops receive sinks, lavatories, or are subjected to liquids. All substrates shall have sink cutout edges sealed with appropriate sealant against moisture. No joints shall occur at any cutouts. A balanced backer sheet is required.

b. All plywood & laminate shall be shop acclimated for 48 hours minimum before assembly.

(1) Edge Style

(a) Front and exposed side countertop edges shall be in shapes and to dimensions as shown on the drawings. The countertop edge material shall be:

1. Post formed plastic laminate. Laminate edge shall be integral with countertop surface. Shape and profile shall be as indicated on the drawings and to dimensions as indicated on the drawings.

2. Hardwood. Species, finish, profile, shape, and dimensions shall be as indicated on the drawings. Hardwood edge shall overlap the exposed countertop laminate edge and shall be installed flush with the countertop laminate surface.

3. Plastic laminate Self Edge. Flat, 90 degree "self" edge. Edge must be applied before top. Laminate edge shall overlap countertop laminate and shall be eased to eliminate sharp corners.

(2) Laminate Clad Splashes

(a) Countertop splash substrate shall be 3/4 inch Grade A faced plywood. Laminate clad backsplash shall be integral with countertop, coved to radius and to dimensions as indicated on the drawings. Side splashes shall be straight profile and provided loose, to be installed at the time of countertop installation. Back and side splash laminate pattern and color shall match the adjacent countertop laminate.

2.11.1.5 Laminate Application

a. Laminate application to substrates shall follow the recommended procedures and instructions of the laminate manufacturer and NEMA LD 3, using tools and devices specifically designed for laminate fabrication and application. Provide a balanced backer sheet (Grade BK) wherever only one surface of the component substrate requires a plastic laminate finish. Apply required grade of laminate in full uninterrupted sheets consistent with manufactured sizes using one piece for full length only, using adhesives specified herein or as recommended by the manufacturer. Fit corners and joints hairline. All laminate edges shall be machined flush, filed, sanded, or buffed to remove machine marks and eased (sharp corners removed). Clean up at easing shall be such that no overlap of the member eased is visible. Fabrication shall conform to ANSI A161.2. Laminate types and grades for component surfaces shall be as follows unless otherwise indicated on the drawings:

(1) Base/Wall Cabinet Case Body.

(a) Exterior (exposed) surfaces to include exposed and semi-exposed face frame surfaces: HPDL Grade VGS.

(b) Interior (semi-exposed) surfaces to include interior back wall, bottom, and side walls: Thermoset Decorative Overlay (melamine).

(2) Adjustable Shelving.

(a) Top and bottom surfaces: Thermoset Decorative Overlay (melamine).

(b) All edges: PVC edge banding.

(3) Fixed Shelving.

(a) Top and bottom surfaces: Thermoset Decorative Overlay (melamine).

(b) Exposed edges: PVC edge banding.

(4) Door, Drawer Fronts, Access Panels.

(a) Exterior (exposed) and interior (semi-exposed) faces: HPDL Grade VGS.

(b) Edges: PVC edge banding.

(5) Drawer Assembly.

(a) All interior and exterior surfaces: Thermoset Decorative Overlay (melamine).

(6) Countertops and Splashes.

(a) All exposed and semi-exposed surfaces: HPDL Grade HGS

(7) Tolerances

(a) Flushness, flatness, and joint tolerances of laminated surfaces shall meet the AWI Qual Stds custom grade requirements.

2.11.1.6 Finishing

a. Filling

(1) No fasteners shall be exposed on laminated surfaces. All nails, screws, and other fasteners in non-laminated cabinet components shall be countersunk and the holes filled with wood filler consistent in color with the wood species.

b. Sanding

(1) All surfaces requiring coatings shall be prepared by sanding with a grit and in a manner that scratches will not show in the final system.

c. Coatings

(1) Types, method of application and location of casework finishes shall be in accordance with the finish schedule, drawings and Section 09 90 00 Paints And Coatings. All cabinet reveals shall be painted.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Installation shall comply with applicable requirements for AWI Qual Stds custom quality standards. Countertops and fabricated assemblies shall be installed level, plumb, and true to line, in locations shown on the drawings. Cabinets and other laminate clad casework assemblies shall be attached and anchored securely to the floor and walls with mechanical fasteners that are appropriate for the wall and floor construction.

3.1.1.1 Anchoring Systems

a. Floor

(1) Base cabinets shall utilize a floor anchoring system. Anchoring and mechanical fasteners shall not be visible from the finished side of the casework assembly. Cabinet assemblies shall be attached to anchored bases without visible fasteners. Where assembly abutts a wall surface, anchoring shall include a minimum 1/2 inch thick lumber or panel product hanging strip, minimum 2-1/2 inch width; securely attached to the top of the wall side of the cabinet back.

b. Wall

(1) Cabinets to be wall mounted shall utilize minimum 1/2 inch thick lumber or panel product hanging strips, minimum 2-1/2 inch width; securely attached to the wall side of the cabinet back, both top and bottom.

3.1.1.2 Countertops

a. Countertops shall be installed in locations as indicated on the drawings. Countertops shall be fastened to supporting casework structure with mechanical fasteners, hidden from view. All joints formed by the countertop or countertop splash and adjacent wall surfaces shall be filled with a clear silicone caulk. Loose side splashes shall be adhered to both the countertop surface perimeter and the adjacent wall surface with adhesives appropriate for the type of materials to be adhered. Joints between the countertop surface and splash shall be filled with clear silicone caulk in a smooth consistent concave bead. Bead size shall be the minimum necessary to fill the joint and any surrounding voids or cracks.

3.1.1.3 Hardware

a. Casework hardware shall be installed in types and locations as indicated on the drawings.

3.1.1.4 Doors, Drawers and Removable Panels

a. The fitting of doors, drawers and removable panels shall be accomplished within target fitting tolerances for gaps and flushness in accordance with AWI Qual Stds custom grade

requirements.

3.1.1.5 Plumbing Fixtures

a. Sinks, sink hardware, and other plumbing fixtures shall be installed in locations as indicated on the drawings and in accordance with Section 22 00 00 Plumbing, General Purpose.

3.1.1.6 Glass

a. Glass and glazing shall be installed in the casework using methods and materials specified in Section 08 81 00 Glazing in locations as indicated on the drawings.

**** END OF SECTION ****

SECTION 06650
SOLID POLYMER FABRICATIONS

I. GENERAL

1.01 DESCRIPTION

A. Work described in this section:

1. **Lavatory tops with integral bowls**
2. **Window sills**

B. Related work specified elsewhere:

1. **(Finish carpentry.)(Architectural woodwork.)**
2. **Tile work.**
3. **Wall coverings.**
4. **Casework.**
5. **Plumbing.**

1.02 REFERENCES

A. Applicable Standards: Standards of the following, as referenced herein:
- **1. American National Standards Institute (ANSI)**
- **2. American Society for Testing and Materials (ASTM)**
- **3. National Electrical Manufacturers Association (NEMA)**
- **4. Federal Specifications (FS)**

1.03 SUBMITTALS

A. Shop drawings: Indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.

B. Samples: Submit minimum 2" x 2" (50 mm x 50 mm) samples. Indicate full range of color and pattern variation. Approved samples will be retained as standards for work.

C. Product data: Indicate product description, fabrication information and compliance with specified performance requirements.

D. Maintenance data: Submit manufacturer's care and maintenance data, including repair and cleaning instructions. Include in project close-out documents.

1.04 QUALITY ASSURANCE

A. Allowable tolerances:
- **1. Variation in component size: ± 1/8" (3 mm).**
- **2. Location of openings: ± 1/8" (3 mm) from indicated location.**

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver no components to project site until areas are ready for installation. Store components indoors prior to installation.

B. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.06 WARRANTY

A. Provide manufacturer's 10 year warranty against defects in materials. Warranty shall provide material and labor to repair or replace defective materials. Damage caused by physical or chemical abuse or damage from excessive heat will not be warranted.

B. This Warranty *[(1)]* applies to Commercially installed CORIAN Products:

1. **Purchased after January 1, 1987, for use in the United States, Canada, or Mexico**
2. **Which are maintained according to the DuPont CORIAN Care and Maintenance brochure (H-47338) and the Commercial or Residential Care and Maintenance Video. A copy may be obtained, free of charge, from your DuPont Certified Fabrication/Installation Source or by calling DuPont at 1-800-4CORIAN (1-800-426-7426).**

Refer to the Commercial Warranty Card[s] for complete details.

II. PRODUCTS

2.01 SOLID POLYMER FABRICATIONS

A. Specified product: CORIAN® SURFACES from The DuPont Company

Provide 3/4" thick counter tops & splashes. Ease all exposed edges; provide matching sealant.

B. Material: Homogeneous filled acrylic; not coated, laminated or of composite construction; meeting ANSI Z124.3 & .6, Type Six, and Fed. Spec. WW-P-541E/GEN.

1. **Material shall have minimum physical and performance properties specified in the following Section U.**
2. **Superficial damage to a depth of 0.010" (,25 mm) shall be repairable by sanding and polishing.**

~~**C. Tub and shower walls; 1/4" (6 mm) thick, standard panels of CORIAN, consisting of four 1/4" x 57" x 29 5/16", _____ color. (Technical Bulletin H-20371, H-03836, Technical Drawing: MASON1, WETWALLS, DRYWALLS, WETWLNGS)**~~

D. Toilet and Shower partitions: Panels and pilasters of 3/4" (19 mm) thick CORIAN, _____ color. Pilasters attached at floor and ceiling. Provide with hardware for attachment of panels to pilasters as indicated on the Architect's Drawings. (Technical Bulletin: H-03836)

E. Wall cladding / wainscoting , 1/4" (6 mm) thick, with [butt joints] or [1/8" (3 mm) wide joints] sealed with color matching Silicone Sealant for DuPont CORIAN; adhesively applied to solid substrates; _____ color.

F. Bumper rails: Fabricated of [1/2"(13 mm)][3/4"(19mm)] CORIAN to size and shape with edge details as specified on the Architect's Drawings; adhesively joined with inconspicuous seams; _____ color. Install bumper rails without exposed fasteners.

G. Interior Steps: Stringers of 1" plywood, one on each end, others as needed to provide 12" maximum spacing between stringers. Stringer ends to be covered with [1/4" (6 mm)][1/2" (13 mm)] thick CORIAN; _____ color. Tread of 1/2" (13 mm) thick CORIAN; sand with 120 grit sandpaper; _____ color. Horizontal support of 1" plywood. Riser of 1/4" (6 mm) thick CORIAN; _____ color, with vertical kicker (typically 1/4" plywood.) Details are for up to 3 steps only. Larger assemblies require 2" x 12" stringers as specified on the Architect's Drawings.
(Technical Drawing:STEPS)

H. Seats: Seating surfaces of [(1/2" (13 mm)][3/4"(19mm)] thick CORIAN; _____ color. Attach to support structure with silicone sealant and/or thru bolts as specified on the Architect's Drawings. [Technical Drawing: SEATS]

I. Laboratory countertops: [1/2" (13 mm)] [3/4" (19 mm)] thick CORIAN, adhesively joined with inconspicuous seams; edge details as specified on the Architect's Drawings; _____ color; [complete with specified bowls]. Surfaces to be unaffected by Class I reagents and repairable after exposure to Class II reagents.([Architect Note - See DuPont literature on CORIAN for list of typical Class I and Class II reagents.](Technical Bulletin: H-16309)

J. Reception areas/nurses' stations: Horizontal surfaces of [1/2" (13 mm)][3/4" (19 mm)] thick CORIAN adhesively joined with inconspicuous seams; edge details as indicated on the Architect's Drawings; _____ color. Vertical surfaces shall be [1/4" (6 mm)][1/2" (13 mm)][3/4" 919 mm)] material as shown on the Architect's Drawings;_____color.

K. Table tops: [1/2" (13 mm)][3/4" (19 mm)] thick CORIAN, adhesively joined with inconspicuous seams; edge details as indicated on the Architect's Drawings; _____ color. [Technical Bulletin: H-26278]

L. Bar tops: [1/2" (13 mm)][3/4"(19 mm)] thick CORIAN, adhesively joined with inconspicuous seams; edge details as indicated on the Architect's Drawings; _____ color. [Technical Bulletin: H-26278, CTDC 122]

(*)SPECIAL REQUIREMENTS FOR HOT AND COLD APPLICATIONS.

M. (*) Cold cafeteria surfaces: [1/2" (13 mm)][3/4" (19 mm)] thick CORIAN, adhesively joined with inconspicuous seams; edge details as indicated on the Architect's Drawings; _____ color. [Technical Bulletins:, CTDC 119, 124, 125]

1. **Make cutouts to templates furnished by the cold appliance manufacturer.**
2. **Reinforce joints and cutouts as recommended by the surfacing manufacturer.**
3. **Provide insulation between CORIAN and adjacent cold pans.**
4. **Thermally isolate hot applications from cold.**

N. (*) Hot cafeteria surface: [1/2" (13 mm)][3/4" (19 mm)] thick CORIAN, adhesively joined with inconspicuous seams; edge details as indicated on the Architect's Drawings; _____ color. [Technical Bulletins:, CTDC-119, 124, 125]

1. **Provide expansion joints in countertop as detailed on the Architect's Drawings.**
2. **Make cutouts to templates furnished by the hot appliance manufacturer.**
3. **Reinforce joints and cutouts as recommended by the surfacing manufacturer.**
4. **Provide insulation between CORIAN and adjacent hot water pans and food warmers.**
5. **Thermally isolate hot applications from cold.**
6. **Provide venting of cabinets. (*Architect must design and specify.)***

O. **Countertops with sinks: [1/2" (13 mm)][3/4" (19 mm)] thick countertop of CORIAN; edge details as indicated on the Architect's Drawings, complete with [undermount][seamed "S" mount][bevel mount][single bowl][double bowl][double bowl with molded drainboard] sink. Provide counter complete with backsplash of size shown on the Architect's Drawings. Countertop and backsplash shall be _designer white_ color to be selected color. Sink shall be _____ model and ___designer white___ color. *(Note: when bevel mounting the same color sink/bowl as the sheet, the "step-down" or recessed mount is recommended.)***

P. **Free standing island countertops with sinks: [1/2" (13 mm)][3/4" (19 mm)] thick countertop of CORIAN; edge details as indicated on the Architect's Drawings; complete with [undermount][seamed "S" mount][bevel mount][single bowl][double bowl][double bowl with molded drainboard] sink. Island shall be _____ color. Sink shall be _____ model and _____ color. *(Note: when bevel mounting the same color sink/bowl as the sheet, the "step-down" or recessed mount is recommended.)***

Q. **Lavatory tops with seamed bowls; [1/2" (13 mm)][3/4" (19 mm)] thick countertop of CORIAN, having edge details as indicated on the Architect's Drawings, complete with [seamed "S"undermount] [bevel mount] bowl. Provide countertops complete with backsplashes of size shown on the Architect's Drawings. *(Technical Bulletin H-16307)* Countertop and backsplash shall be _____ color. [specify number] bowl(s) shall be _____ model and _____ color. *(Note: when bevel mounting the same color sink/bowl as the sheet, the "step-down" or recessed mount is recommended.)***

R. **Lavatory tops with undermount bowls: [1/2" (13 mm)][3/4" 19 mm)] thick countertop of CORIAN; edge details as indicated on the Architect's Drawings, complete with [specify number] undermount bowl[s]. Provide countertops complete with backsplashes of size shown on the Architect's Drawings. Use undermount hardware according to manufacturer's instructions. (Technical Bulletin H-16307,] Vanity top and backsplash shall be _____ color. Bowl[s] shall be _____model and _____ color. (*For ADA compliance, refer to Technical Drawings ADABOWL, ADATEMP for installation details.)***

S. **Lavatory tops with integral bowls: molded countertop of CORIAN [19 1/2" (500 mm)][22" (560 mm)], complete with integrally molded bowl[s] of CORIAN; edge details as indicated on the Architect's Drawings. Provide with cove backsplash [and endsplashes] as shown on the Architect's Drawings. _____ model and ___designer white___ color. [Technical Bulletin CTDC-128].**

T. **Window sills: [1/2" (13 mm)][3/4" (19 mm)] thick CORIAN, adhesively joined with inconspicuous seams; edge details as indicated on the Architect's Drawings;** color to be selected. **__white_____ color. [Technical Bulletin: CTDC-130].**

U. **Performance characteristics:**

PROPERTY	REQUIREMENT	TEST PROCEDURE
Tensile Strength	6000 psi	ASTM D 638
Tensile Modulus	1.5 x 10^6 psi	ASTM D 638
Flexural Strength	7890 psi	ASTM D 790
Flexural Modulus	1.4 x 10^6 psi	ASTM D 790
Elongation	0.4%	ASTM D 638
Strain at Break	0.81%	ASTM D 638
Work to Break	2.48 in. lbs.	ASTM D 638
Hardness	94 Rockwell "M" Scale 56 Barcol Impressor	ASTM D 785

Thermal Expansion	**3.02 x 10^{-6} in/in/°C**			**ASTM D 696**
	1.80 x 10^{-6} in/in/°F			
Thermal Conductivity	**7.0 Btu/hr/sq ft °F**			**DuPont Test**
Specific Heat	**0.2935 + (0.001 % °C) pcu/lb °C**			**DuPont Test**
Volumetric Heat Capacity	**0.33 Btu/lb °F**			**DuPont Test**
Gloss (60 Gardner)	**5-80 (matte-polished)**			**NEMA LD 3-3.15**
Color Stability	**No Change - 200 hrs**			**NEMA LD 3-3.10**
Wear and Cleanability	**Passes**			**ANSI Z 124.3**
Abrasion Resistance	**No loss of pattern Wt loss (1,000 cycles) - 0.2 gm Wear (10,000 cycles) - .008"**			**NEMA LD 3-3.10**
Boiling Water Surface Resistance	**No Change**			**NEMA LD 3-3.05**
High Temperature Resistance	**No Change**			**NEMA LD 3-3.06**
Conductive Heat Resistance	**No Change**			**NEMA LD 3-3.08**
Impact Resistance Notched Izod Gardner	**.28 ft. lbs/in. of notch solid colors 9.3 ft. lbs particulate colors 13.3 ft. lbs**			ASTM D 256 (Method A) ASTM D 3029
Ball Drop 1/4" (6 mm) sheet 1/2" (13 mm) sheet 3/4" (19 mm) sheet	**>36" w 1/2 lb ball, no failure >144" w 1/2 lb ball, no failure >204" w 1/2 lb ball, no failure**			**NEMA LD 3-3.03**
Bowls (Point Impact)	No cracks or chips			**ANSI Z124.3 and 124.6**
Stain Resistance	Passes			**ANSI Z124.3**
	Rating - 41 (modified*)			**ANSI Z124.3(modified)**
Weatherability	No Change - 1000 hours			**ASTM D 1499**
Fungi and Bacteria	No Attack			**ASTM G 21, G 22**
Specific Gravity solid colors particulate colors	**1.8 1.69**			
Material Weight solid colors particulate colors	**1/4" (6 mm), 1/2" (13 mm), 3/4" (19 mm) 2.35 4.7 7.0 lbs/sq. ft 2.1 4.2 6.2 lbs/sq. ft.**			
Water Absorption 3/4" (12 mm) sheet 1/4" (6 mm) sheet	**After 24 hrs 0.04% 0.09%**	**Long Term 0.94% 0.8%**		**ASTM D 570**
Flammability solid colors Flame Spread Smoke Developed Class Rating	**1/4"(6 mm) 25(15) 25(20) 1**	**1/2"(13mm) 5 10 1**	**3/4" (19mm) 5 15 1**	**ASTM E84**
particulate colors Flame Spread Smoke Developed Class Rating	** 20 5 1**	** 15 25 1**	** 15 30 1**	
Oxygen Index	**0.357**			**ASTM D 2863**

Pittsburgh Protocol Toxicity (as used by NY State)	**solid colors 99 grams particulate colors 67 grams**	**"LC 50" Test**
Coefficient of Friction	**0.189 static 0.171 dynamic**	**DuPont Test TD-511-A**
Arc Resistance	**190 seconds, no track 60 seconds, rerun, no track**	**ASTM D 495**
Dielectric Strength solid colors particulate colors	** 275 volts/0.001" 263 volts/0.001"**	**ASTM D 149**
Dielectric Constant solid colors particulate colors	** 4.96 at 100 Hz 4.46 at 100 Hz**	**ASTM D 150**
Dissipation Factor solid colors particulate colors	** 0.0698 at 100 Hz 0.077 at 100 Hz**	**ASTM D150**
Surface Conductivity solid colors	** 5.0 x 10^{16} Mho**	**DuPont Test TD-533-A**

*** additional stains used**

Volume Conductivity solid colors	** 4.7 x 10^{16}Mho**	**DuPont Test TD-533-A**
Volume Resistivity solid colors particulate colors	** 4.2 Ohms cm x 10^{-14} 10.0 Ohms cm x 10^{-14}**	**ASTM D 257**
Electrical Charge Relaxation Time solid colors	** 560 seconds**	**PTMS 101B, MIL B-81705**
Heat of Combustion	**2.20 cal/gm**	**Oxygen bomb (calorimeter method)**

2.02 ACCESSORY PRODUCTS

A. Joint adhesive: Manufacturer's standard two-part adhesive kit to create inconspicuous, non-porous joints, with a chemical bond. (Technical Bulletin: CTDC 102)

(RETAIN BELOW FOR TUB/SHOWER SYSTEMS)

B. Panel Adhesive: Manufacturer's standard neoprene-based panel adhesive meeting ANSI A 136.1-1967 UL® listed. (Technical Bulletin: CTDC 102)

C. Sealant: Manufacturer's standard mildew-resistant, FDA/UL® recognized silicone sealant in color matching or clear formulations. (Technical Bulletin: 102, 127)

(RETAIN BELOW FOR UNDERMOUNT SINKS AND BOWLS)

D. Sink/Bowl mounting hardware: Manufacturer's approved bowl clips, brass inserts and fasteners for attachment of undermount sinks/bowls.

2.03 FABRICATION

A. [Fabrications to be performed by a Certified CORIAN fabricator/installer.]

B. Fabricate components in shop to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and DuPont requirements. (Technical Bulletin: CTDC-117)

C. Form joints between components using manufacturer's standard joint adhesive. Joints shall be inconspicuous in appearance and without voids. Attach 2" (50 mm) wide reinforcing strip of CORIAN under each joint. [Technical Bulletins: CTDC-124, 129, 134]

D. Provide holes and cutouts for plumbing and bath accessories as indicated on the drawings.

E. Rout and finish component edges to a smooth, uniform finish. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

F. Finish: All surfaces shall have uniform finish. [Technical Bulletins:CTDC100, 123, 132]

1. [Matte ,with a gloss rating of 5 - 20.] ***(This the standard finish and is the lowest maintenance finish.)***

2. [Semigloss, with a gloss rating of 25-50] ***(Adds an upcharge. Select semigloss to bring out the depth of colors in the darker Sierra and Jewel tones. It requires more maintenance.)***

3. [Polished, with a gloss rating of 55 - 80.] ***(A high gloss finish, ideal for applications that require maximum smoothness and reflectance. Recommended for light duty only. Maintenance will be increased.)***

G. ***(Optional)*** **Thermoforming: Comply with forming data from manufacturer. (Technical Bulletin CTDC-110]**

1. **Construct matching molds of plywood to form component shape.**
2. **Form pieces to shape prior to seaming and joining.**
3. **Cut pieces larger than finished dimensions. Sand edges. Remove all nicks and scratches.**
4. **Heat entire component uniformly between 275-325°F during forming.**
5. **Prevent blistering, whitening and cracking of CORIAN during forming.**

H. ***(Optional)*** **Cove backsplashes: Fabricate 1/2" (13 mm) radius cove at intersection of counters and backsplashes. Form backsplashes using [1/2" (13 mm)][3/4" (19 mm)] CORIAN. Fabricate in shop or field. [Technical Bulletin: CTDC-112]**

I. ***(Optional)*** **Colored inlays: Fabricate using manufacturer's approved method. (Technical Bulletin CTDC-103)**

1. **Rout 1/8" max deep groove for inlay to pattern indicated on Architect's Drawings.**
2. **Fill groove using methods approved by manufacture, avoiding air bubbles or voids. Overfill inlay area.**
3. **Allow area to fully cure. Do not overheat inlay while sanding. Finish and touch up to uniform appearance.**

[Refer to DuPont CORIAN Fabrication and Installation manual E-88639. Technical information and a listing of the registered DuPont CORIAN fabricator/installers can be provided by the local DuPont CORIAN distributor.]

III. EXECUTION

3.01 JOB MOCK-UP

A. Prior to final approval of shop drawings, erect one full size mock-up of each component at project site for architect review.

B. Should mock-up not be approved, rework or remake until approval is secured. Remove rejected units from project site.

C. Approved mock-ups shall remain as part of finished work.

3.02 INSTALLATION

A. Install components plumb and level, in accordance with approved shop drawings and product installation details.

B. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work. Keep components and hands clean when making joints.

C. Adhere undermount/submount/bevel mount sinks/bowls to countertops using manufacturer's recommended adhesive and mounting hardware. [Technical Bulletin H-16307]

D. Adhere topmount sinks/bowls to countertops using manufacturer recommended adhesives and color-matched silicone sealant.

E. Provide backsplashes and endsplashes as indicated on the drawings. Adhere to countertops using manufacturer's standard color-matched silicone sealant.

F. Keep components and hands clean during installation. Remove adhesives, sealants and other stains. Components shall be clean on Date of Substantial Completion..

G. Make plumbing connections to sinks in accordance with Division 15. Mechanical.

H. Protect surfaces from damage until Date of Substantial Completion. Repair or replace damaged work that cannot be repaired to architect's satisfaction and invoice for the cost of repairs. Architect to pre-approve cost estimate before repairs are made.

I. Fabricator/Installer is to provide the CORIAN [Commercial][Residential] Care and Maintenance video, review maintenance procedures and the DuPont warranty with the head of maintenance upon completion of project.

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless other wise noted, the latest published version and/or revision shall be used.

1.1.1.1 ASTM INTERNATIONAL (ASTM)

a.	ASTM C 1187	Asphalt-Base Emulsions for Use as Protective Coatings for Metal
b.	ASTM D 1227	Emulsified Asphalt Used as a Protective Coating for Roofing
c.	ASTM D 6506	Standard Specification for Asphalt Based Protection for Below Grade Waterproofing
d.	ASTM D 41	Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
e.	ASTM D 4263	Indicating Moisture in Concrete by the Plastic Sheet Method
f.	ASTM D 4479	Asphalt Roof Coatings - Asbestos-Free
g.	ASTM D 449	Asphalt Used in Dampproofing and Waterproofing

1.1.1.2 U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

a.	29 CFR 1926	Safety and Health Regulations for Construction

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register:

1.2.1.1 SD-07 Certificates

a. Materials

1.3 DELIVERY AND STORAGE

1.3.1 Deliver materials in sealed containers bearing manufacturer's original labels. Labels shall include date of manufacture, contents of each container, performance standards that apply to the contents and recommended shelf life.

1.4 SAFETY AND HEALTH REQUIREMENTS

1.4.1 If coal-tar pitch materials are used, the Contractor shall conform to all OSHA 29 CFR 1926 and General Industry Health Standards as well as state and local standards.

PART 2 PRODUCTS

2.1 DAMPPROOFING PRODUCTS

2.1.1 Provide Asphalt Primer, Asphalt, Fibrous Asphalt or Emulsion Based Dampproofing as indicated or required. Where damproofing is indicated but not defined by type, use Non-Fribrated Emulsion Based Damproofing over the required Asphalt Primer.

2.2 ASPHALT

2.2.1 ASTM D 449 Type 1 or Type II.

2.3 ASPHALT PRIMER

2.3.1 ASTM D 41

2.4 COAL TAR PITCH

2.4.1 ASTM D 450, Type II or Type III

2.5 FIBROUS ASPHALT

2.5.1 ASTM D 4479, Type I for horizontal surfaces, Type II for vertical surfaces.

2.6 EMULSION BASED ASPHALT DAMPPROOFING

2.6.1 Fibrated Emulsion-Based Asphalt

2.6.1.1 Fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1227 Type IV, asbestos-free, manufactured of refined asphalt, emulsifiers and selected clay, fibrated with mineral fibers. For spray or brush application, emulsion shall contain a minimum of 59 percent solids by weight, 56 percent solids by volume. For trowel application, emulsion shall contain a minimum of 58 percent solids by weight, 55 percent solids by volume.

2.6.2 Non-Fibrated Emulsion-Based Asphalt

2.6.2.1 Non-fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1187 Type II or ASTM D 1227 Type III, manufactured of refined asphalt, emulsifiers and selected clay. Asphalt shall contain a minimum 58 percent solids by weight, 55 percent solids by volume.

2.7 SURFACE PROTECTION

2.7.1 Asphalt Protection Board

2.7.1.1 ASTM D 6506, Type B, fiberglass faced asphalt protection board; 1/8” thick or greater if required by dampproof coating manufacturer.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 Remove or cut form and ties or protrusions that would disrupt the film and repair all surface defects as required in Section 03 30 00.20 Cast-In-Pace Concrete. Clean concrete or masonry surfaces to receive dampproofing of foreign matter and loose particles. Apply dampproofing to clean dry surfaces. Moisture test in accordance with ASTM D 4263. If test indicates moisture, allow a minimum of 7 additional days after test completion for curing. If moisture still exists, redo test until substrate is dry.

3.1.1.1 Metal Surfaces

a. Metal surfaces shall be dry and be free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

3.2 PROTECTION OF SURROUNDING AREAS

3.2.1 Before starting the dampproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of dampproofing material onto other work. Any drains and conductors shall be protected from clogging with dampproofing material.

3.3 APPLICATION

3.3.1 Use either hot-application or cold-application method as indicated or required. Prime surfaces to receive fibrous asphaltic dampproofing unless recommended otherwise by dampproofing materials manufacturer. Apply dampproofing after priming coat is dry, but prior to any deterioration of primed surface, and when ambient temperature is above 40 degrees F.

3.3.2 Surface Priming

3.3.2.1 If required by the dampproofing manufacturer, prime surfaces to receive asphaltic dampproofing. Apply primer when ambient temperature is above 40 degrees F, fully covering entire surface to be dampproofed.

3.3.3 Hot-Application Method

3.3.3.1 If chosen as a dampproofing system, apply two mop coats of hot asphalt to surfaces. Apply mop coats uniformly using not less than 20 pounds of asphalt per 100 square feet for each coat. Do not heat asphalt above 450 degrees F. Have kettlemen in attendance at all times during heating to ensure that maximum temperature specified is not exceeded. Apply hot asphalt bitumen and fully bond to primed surface. Provide finished surface that is smooth, lustrous, and impervious to moisture. Recoat dull or porous spots.

3.3.4 Cold-Application Method

3.3.4.1 Emulsion-Based Asphalt

a. If chosen as a dampproofing system, emulsion-based asphalt dampproofing work shall not be performed in temperatures below 40 degrees F. Emulsions shall have a smooth and uniform consistency at time of application. Dampproofing materials shall be applied in accordance with manufacturer's published instructions to produce a smooth uniform dry film of not less than 12

mils thick without voids or defects. Dull or porous spots shall be recoated. Dampproofing materials shall seal tightly around pipes and other items projecting through dampproofing. Rates of application shall be as follows:

(1) Primer: 1/2 gallon per 100 square feet cold-applied, 1/2 gallon per 100 square feet cold-applied.

(2) Fibrated Dampproofing: 2 gallons per 100 square feet, 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

(3) Non-fibrated Dampproofing: 2 gallons per 100 square feet, 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

3.3.5 PROTECTIVE COVERING

3.3.5.1 Protect dampproofed surfaces against which backfill will be placed with one layer of fiberglass faced asphalt protection board conforming to the requirements specified herein. Embed boards in the second coating of bitumen tightly butting edges.

**** END OF SECTION ****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless other wise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

a. AAMA 501 Methods of Test for Exterior Walls

1.1.1.2 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

a. AASHTO T 259 Resistance of Concrete to Chloride Ion Penetration

b. AASHTO T 260 Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials

1.1.1.3 ASTM INTERNATIONAL (ASTM)

a. ASTM C 140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

b. ASTM C 642 Density, Absorption, and Voids in Hardened Concrete

c. ASTM C 672 Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals

d. ASTM D 1653 Water Vapor Transmission of Organic Coating Films

e. ASTM D 2369 Volatile Content of Coatings

f. ASTM D 3278 Flash Point of Liquids by Small Scale Closed-Cup Apparatus

g. ASTM E 514 Water Penetration and Leakage Through Masonry

h. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials

i. ASTM G 53 Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

1.1.1.4 U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

a. 29 CFR 1910.1000 Air Contaminants

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-03 Product Data

a. Water Repellants

1.2.1.2 SD-06 Test Reports

a. Water Absorption

b. Accelerated Weathering

c. Resistance to Chloride Ion Penetration

d. Moisture Vapor Transmission

e. Scaling Resistance

f. Water Penetration and Leakage

1.2.1.3 SD-07 Certificates

a. Manufacturer’s Qualifications

b. Applicator’s Qualifications

c. Evidence of Acceptable Variation

d. Warranty

1.2.1.4 SD-08 Manufacturer’s Instructions

a. Application Instructions

b. Provide manufacturer's instructions including preparation, application, recommended equipment to be used, safety measures, and protection of completed application.

c. Manufacturer’s Material Safety Data Sheets

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

1.3.1.1 Manufacturer's qualifications: Minimum five years record of successful in-service experience of water repellent treatments manufactured for the indicated or required product.

1.3.1.2 Applicator's qualifications: Minimum five years successful experience in projects of similar scope using specified or similar treatment materials and manufacturer's approval for application.

1.3.2 Performance Requirements

1.3.2.1 Water absorption: ASTM C 140. Comparison of treated and untreated specimens.

1.3.2.2 Moisture vapor transmission: ASTM E 96. Comparison of treated and untreated specimens.

1.3.2.3 Water penetration and leakage through masonry: ASTM E 514.

1.3.3 Evidence of Acceptable Variation

1.3.3.1 If a product proposed for use does not conform to requirements of the referenced specification, submit for approval to the Contracting Officer, evidence that the proposed product is either

equal to or better than the product specified. Include the following:

a. Identification of the proposed substitution;

b. Reason why the substitution is necessary;

c. A comparative analysis of the specified product and the proposed substitution, including tabulations of the composition of pigment and vehicle;

d. The difference between the specified product and the proposed substitution and

e. Other information necessary for an accurate comparison of the proposed substitution and the specified product.

1.4 SAMPLE TEST PANEL

1.4.1 The approved Sample Test Panel will serve as the standard of quality for all other water repellent coating work. Do not proceed with application until the sample panel has been approved by the Contracting Officer.

1.4.2 Sample Test Panel

1.4.2.1 Prior to commencing work, including bulk purchase and delivery of material, apply water repellent treatment to a minimum 4 feet high by 4 feet long test-panel of the surface or surfaces to be treated using the indicated or required product. Provide a full height expansion joint at mid-panel length. Prepare and seal joint with materials approved for project use.

1.4.3 Testing

1.4.3.1 AAMA 501 Provide field water testing of water repellent treated surfaces in the presence of the Contracting Officer and the water repellent treatment manufacturer's representative.

a. Apply water repellent to left side of mock-up and allow to cure prior to application of treatment to right side.

b. Twenty days after completion of application of treatment, test mock-up with 5/8 inch garden hose, with spray nozzle, located 10 feet from wall and aimed upward so water strikes wall at 45 degree downward angle. After water has run continuously for three hours observe back side of mock-up for water penetration and leakage. If leakage is detected make changes as needed and retest.

c. Coordinate testing procedures and modify project treatment application as required to pass mock-up tests for water penetration and leakage resistance.

1.4.4 Approval

1.4.4.1 Proceed with water repellent treatment work only after completion of field test application and approval of mock-up and tests by the Contracting Officer.

1.4.5 Pre-Installation Meeting

1.4.5.1 Attend pre-installation meeting required prior to commencement of concrete, concrete masonry, or plaster to be treated product installation.

1.4.5.2 Review procedures and coordination required between water repellent treatment work and work

of other trades which could affect work to be performed under this section of the work.

1.4.5.3 Convene additional pre-installation meeting prior to water repellent treatment application for coordination with work not previously coordinated including joint sealants.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Deliver materials in original sealed containers, clearly marked with the manufacturer's name, brand name, type of material, batch number, percent solids by weight and volume, and date of manufacturer. Store materials off the ground, in a dry area where the temperature will be not less 50 degrees F nor more than 85 degrees F.

1.6 SAFETY METHODS

1.6.1 Apply coating materials using safety methods and equipment in accordance with Section 01 57 19.00 20 Temporary Environmental Controls, and the following:

1.6.2 Toxic Materials

1.6.2.1 To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The coating manufacturer when using solvents or other chemicals. Use impermeable gloves, chemical goggles or face shield, and other recommended protective clothing and equipment to avoid exposure of skin, eyes, and respiratory system. Conduct work in a manner to minimize exposure of building occupants and the general public.

b. 29 CFR 1910.1000.

c. Threshold Limit Values (R) of the American Conference of Governmental Industrial Hygienists.

d. Manufacturer's material safety data sheets.

1.7 ENVIRONMENTAL CONDITIONS

1.7.1 Weather and Substrate Conditions

1.7.1.1 Do not proceed with application of water repellents under any of the following conditions, except with written recommendations of manufacturer.

a. Ambient temperature is less than 40 degrees F.

b. Substrate faces have cured less than one month.

c. Rain or temperature below 40 degrees F are predicted for a period of 24 hours before or after treatment.

d. Earlier than three days after surfaces are wet.

e. Substrate is frozen or surface temperature is less than 40 degrees F and falling.

1.7.2 Moisture Condition

1.7.2.1 Determine moisture content of substrate meets manufacturer's requirements prior to application of water repellent material.

1.8 SEQUENCING AND SCHEDULING

1.8.1 Masonry Surfaces

1.8.1.1 Do not start water repellent coating until all joint tooling, pointing and masonry cleaning operations have been completed. Allow masonry to cure for at least 60 days under normal weather conditions before applying water repellent.

1.8.2 Plaster Surfaces

1.8.2.1 Do not start water repellent coating until all shrinkage and stress cracks are repaired and sound, all surfaces are free of defects and cleaning operations have been completed. Allow plaster to cure for at least 30 days under normal weather conditions before applying water repellent.

1.8.3 Concrete Surfaces

1.8.3.1 Do not start water repellent coating until all patching, pointing and cleaning operations have been completed and concrete has cured a minimum of 30 days under normal weather conditions.

1.8.4 Sealants

1.8.4.1 Do not apply water repellents until the sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.

a. Water repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.

b. Provide manufacturers' test results of compatibility.

1.9 INSPECTIONS

1.9.1 Notify the manufacturer's representative a minimum of 72 hours prior to scheduled application of water repellents for field inspection. Inspect surfaces and obtain approval in writing from the manufacturer's representative prior to any application of any water repellent coating.

1.10 SURFACES TO BE COATED

1.10.1 Coat all exterior indicated or required concrete, masonry or plaster surfaces. This includes back faces of parapets, top of walls, edges and returns adjacent to windows and door frames and free standing walls

1.11 WARRANTY

1.11.1 Provide a warranty, issued jointly by the manufacturer and the applicator of the water repellent treatment against moisture penetration through the treated structurally sound surface for a period

of five years. Warranty to provide the material, labor, and equipment necessary to remedy the problem. At the satisfactory completion of the work, complete the warranty sign, notarize, and submit to the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

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

2.2 WATER REPELLANTS

2.2.1 Silane, 20 Percent SolidS

2.2.1.1 Penetrating water repellent. A monomeric compound containing approximately 20 percent alkyltrialkoxysilanes with alcohol, mineral spirits, water, and other proprietary solvent carrier.

a. Composition: Modified alkylalkoxysilane.

b. Active alkylalkoxysilane content: ASTM D 2369 20 percent by weight, plus or minus 1 percent.

c. Appearance: White, milky liquid.

d. Average depth of penetration: Up to 3/8 inchdepending on substrate.

e. VOC content: Less than 3.2 lbs per gallon.

f. Flash point, ASTM D 3278.

g. Specific gravity, at 78 degrees F: 0.96 to 0.98.

h. Density: 8.0 to 8.2 pounds per gallon.

2.2.2 Silane, 40 Percent Solids

2.2.2.1 Penetrating water repellent. A monomeric compound containing approximately 40 percent alkyltrialkoxysilanes with alcohol, mineral spirits, or water.

a. Composition: Modified alkylalkoxysilane.

b. Active alkylalkoxysilane content: ASTM D 2369 40 percent by weight, plus or minus 1.5 percent.

c. Appearance: White, milky liquid.

d. Average depth of penetration: Up to 3/8 inch depending on substrate.

e. VOC content: Less than 3.2 lbs per gallon.

f. Flash point, ASTM D 3278.

g. Specific gravity, at 78 degrees F: 0.94 to 0.97.

h. Density: 7.8 to 8.1 pounds per gallon.

2.2.3 Silane, 85 Percent Solids or Greater

2.2.3.1 Penetrating water repellent. A monomeric compound containing 85 percent or greater alkyltrialkoxysilanes with alcohol, mineral spirits, or water.

a. Composition: Modified alkylalkoxysilane.

b. Active alkylalkoxysilane content: ASTM D 2369 20 percent by weight, plus or minus 1 percent.

c. Appearance: White, milky liquid.

d. Average depth of penetration: Up to 3/8 inchdepending on substrate.

e. VOC content: Less than 3.2 lbs per gallon.

f. Flash point, ASTM D 3278.

g. Specific gravity, at 78 degrees F: 0.96 to 0.98.

h. Density: 8.0 to 8.2 pounds per gallon.

2.2.4 Siloxanes

2.2.4.1 Penetrating water repellent. Alkylalkoxysiloxanes that are oligomerous with alcohol, ethanol, mineral spirits, or water.

a. Solids by weight: ASTM D 2369, 7.5-16.0 percent.

b. Volatile Organic Content (VOC) after blending: Less than 1.6 lbs per gallon.

c. Density, activated: 8.4 pounds per gallon, plus or minus one percent.

d. Flash point, ASTM D 3278: Greater than 212 degrees F.

2.2.5 Low-Solids Acrylic

2.2.5.1 Water-clear, breathing coating of acrylic resins, water-based, solvent-based, or acrylic emulsions solution containing less than 15 percent solids by volume.

2.2.6 High-Solids Acrylic

2.2.6.1 Water-clear, breathing coating of acrylic resins, water-based, solvent-based, or acrylic emulsions solution containing 15 percent solids or more by volume.

2.2.7 VOC-Complying Water Repellents

2.2.7.1 Products certified by the manufacturer that they comply with local regulations controlling use of volatile organic compounds (VOC's).

2.3 PERFORMANCE CRITERIA

2.3.1 Silane, 20 Percent Solid

a. Water absorption test: ASTM C 642 and ASTM E 514.

b. Moisture vapor transmission: ASTM D 1653, 28.33 perms or 51.61 percent maximum compared to untreated surfaces.

c. Scaling resistance: ASTM C 672/C 672M, non-air-entrained concrete, zero rating, no scaling, 100 cycles treated concrete.

d. Resistance to chloride ion penetration: AASHTO T 259 and AASHTO T 260.

e. Water penetration and leakage through masonry, ASTM E 514percentage reduction of leakage: 97 percent minimum.

f. Resistance to accelerated weathering, ASTM G 53 testing 2,500 hours: No loss in repellency.

g. Drying time under normal conditions: Four hours per 75 degrees F.

2.3.2 Silane, 40 Percent Solids

a. Average depth of penetration: 10 mm(3/8 inches) depending on substrate.

b. Resistance to chloride ion penetration, AASHTO T 259 and AASHTO T 260.

c. Water absorption test, ASTM E 514: 0.42 percent per 48 hours; 1.2 percent per 50 days.

d. Moisture vapor transmission: ASTM D 1653, 28.33 perms or 51.61 percent maximum compared to untreated surfaces.

e. Scaling resistance, ASTM C 672/C 672M, non-air-entrained concrete: Zero rating, no scaling, 100 cycles treated concrete.

f. Resistance to accelerated weathering, ASTM G 53. Testing 2,500 hours: No loss in repellency.

g. Drying time under normal conditions: Four hours per 75 degrees F.

2.3.3 Silane, 85Percent Solids or Greater

a. Average depth of penetration: 3/8 inches depending on substrate.

b. Resistance to chloride ion penetration, AASHTO T 259 and AASHTO T 260.

c. Water absorption test, ASTM E 514: 0.42 percent per 48 hours; 1.2 percent per 50 days.

d. Moisture vapor transmission: ASTM D 1653, 28.33 perms or 51.61 percent maximum compared to untreated surfaces.

e. Scaling resistance, ASTM C 672/C 672M, non-air-entrained concrete: Zero rating, no scaling, 100 cycles treated concrete.

f. Resistance to accelerated weathering, ASTM G 53. Testing 2,500 hours: No loss in repellency.

g. Drying time under normal conditions: Four hours per 75 degrees F.

2.3.4 Siloxanes

a. Dry time for recoat, if necessary: One to two hours depending on weather conditions.

b. Penetration: 3/8 inch, depending on substrate.

c. Water penetration and leakage through masonry, ASTM E 514, percentage reduction of leakage: 97.0 percent minimum.

d. Moisture vapor transmission, ASTM E 96: 47.5 perms or 82 percent maximum compared to untreated sample.

e. Resistance to accelerated weathering, ASTM G 53. Testing 2,500 hours: No loss in

repellency.

f. Resistance to chloride ion penetration, AASHTO T 259 and AASHTO T 260.

g. Scaling resistance,ASTM C 672/C 672M, non-air-entrained concrete: Zero rating, no scaling, 100 cycles treated concrete.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Examine the surfaces to be treated to ensure that:

a. All visible cracks, voids or holes have been repaired.

b. All mortar joints in masonry are tight and sound, have not been re-set or misaligned and show no cracks or spalling.

c. Moisture contents of walls does not exceed 15 percent when measured on an electronic moisture register, calibrated for the appropriate substrate.

d. Concrete surfaces are free of form release agents, curing compounds and other compounds that would prevent full penetration of the water repellent material.

3.1.2 Do not start water repellent treatment work until all deficiencies have been corrected, examined and found acceptable to the Contracting Officer and the water repellent treatment manufacturer. Do not apply treatment to damp, dirty, dusty or otherwise unsuitable surfaces. Comply with the manufacturer's recommendations for suitability of surface.

3.2 PREPARATION

3.2.1 Surface Preparation

3.2.1.1 Prepare substrates in accordance with water repellent treatment manufacturer's recommendation. Clean surfaces of dust, dirt, efflorescence, alkaline, and foreign matter detrimental to proper application of water repellent treatment.

3.2.2 Protection

3.2.2.1 Provide masking or protective covering for materials which could be damaged by water repellent treatment.

a. Protect glass, glazed products, and prefinished products from contact with water repellent treatment.

b. Protect landscape materials with breathing type drop cloths: plastic covers are not acceptable.

3.2.3 Compatibility

3.2.3.1 Confirm treatment compatibility with each type of joint sealer within or adjacent to surfaces receiving water repellent treatment in accordance with manufacturer's recommendations.

3.2.3.2 When recommended by joint sealer manufacturer, apply treatment after application and cure of

joint sealers. Coordinate treatment with joint sealers.

3.2.3.3 Mask surfaces indicated to receive joint sealers which would be adversely affected by water repellent treatment where treatment must be applied prior to application of joint sealers.

3.3 MIXING

3.3.1 Mix water repellent material thoroughly in accordance with the manufacturer's recommendations. Mix, in quantities required for that days work, all containers prior to application. Mix each container the same length of time.

3.4 APPLICATION

3.4.1 In strict accordance with the manufacturers written requirements. Do not start application without the manufacturer's representative being present or his written acceptance of the surface to be treated.

3.4.2 Water Repellent Treatment

3.4.2.1 Spray Application

a. Spray apply water repellent material to exterior surfaces to be coated using low-pressure airless spray equipment in strict accordance with manufacturer's printed application, instructions, and precautions. Maintain copies at the job site. Apply flood coat in an overlapping pattern allowing approximately 8 to 10 inch rundown on the vertical surface. Maintain a wet edge at all overlaps, both vertical and horizontal. Hold gun maximum 18 inches from wall.

3.4.2.2 Brush or Roller Application

a. Brush or roller apply water repellent material only at locations where overspray would affect adjacent materials and where not practical for spray applications.

3.4.2.3 Covered Surfaces

a. Coat all exterior surfaces as indicated or required including back faces of parapets, tops of walls, edges and returns adjacent to window and door frames, window sills, and free-standing walls.

3.4.2.4 Rate of Application

a. Apply materials to exterior surfaces at the coverages recommended by the manufacturer and as determined from sample panel test. Increase or decrease application rates depending upon the surface texture and porosity of the substrate so as to achieve even appearance and total water repellency.

3.4.2.5 Number of Coats

a. The sample panel test shall determine the number of coats required to achieve full coverage and protection.

3.4.2.6 Appearance

a. If unevenness in appearance, lines of work termination or scaffold lines exist, or detectable

changes from the approved sample panel occur, the Contracting Officer may require additional treatment at no additional cost to the Government. Apply any required additional treatment to a natural break off point.

3.5 CLEANING

3.5.1 Clean all runs, drips, and overspray from adjacent surfaces while the water repellent treatment is still wet in a manner recommended by the manufacturer.

3.6 FIELD QUALITY CONTROL

3.6.1 Do not remove drums containing water repellent material from the job site until completion of all water repellent treatment and until so authorized by the Contracting Officer.

3.6.2 Field Testing

3.6.2.1 AAMA 501. At a time not less than twenty days after completion of the water repellent coating application, subject a representative wall area of the building to the Navy Hose Stream Field Test similiar to AAMA 501 hose test to simulated rainfall for a period of three hours. Use a minimum 5/8 inch diameter hose and a fixed lawn sprinkler spray head which will direct a full flow of water against the wall. Place the sprinkler head so that the water will strike the wall downward at a 45 degree angle to the wall. If the inside of the wall shows any trace of moisture during or following the test, apply another coat of water repellent, at the manufacturer's recommended coverage rate to the entire building. Repeat testing and re-coating process until no moisture shows on the inside wall face. Accomplish any required work retesting and re-coating at no additional cost to the Government.

3.6.3 Site Inspection

3.6.3.1 Inspect treatment in progress by manufacturer's representative to verify compliance with manufacturer instructions and recommendations.

**** END OF SECTION ****

PART 1 GENERAL

1.1 SUMMARY

This Section specifies the construction and quality control of the installation of an air barrier system. Construct the air barrier system indicated, taking responsibity for the means, methods, and workmanship of the installation of the air barrier system. The air barrier must be contiguous and connected across all surfaces of the enclosed air barrier envelope indicated. The maximum leakage requirements of individual air barrier components and materials are specified in the other specification sections covering these items.[
This section also defines the maximum allowable leakage of the final air barrier system. The workmanship must be adequate to meet the maximum allowable leakage requirements of this specification. Test the assembled air barrier system to demonstrate that the building envelope is properly sealed and insulated. Passing the air barrier system leakage test and thermography test will result in system acceptance. Conform air barrier system leakage and thermography testing and reporting to the requirements of Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS.]

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4541	(2009; E 2010) Pull-Off Strength of Coatings Using Portable Adhesion Testers

1.3 DEFINITIONS

The following terms as they apply to this section:

1.3.1 Air Barrier Accessory

Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).

1.3.2 Air Barrier Assembly

The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.

1.3.3 Air Barrier Component

Pre-manufactured elements such as windows, doors, dampers and service elements that are installed in the environmental separator.

1.3.4 Air Barrier Envelope

The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. There may be more than one air barrier envelope in a single building. Also known as Air Barrier System.

1.3.5 Air Barrier Material

A building material that is designed and constructed to provide the primary resistance to airflow through an air barrier assembly.

1.3.6 Air Barrier System

Same as AIR BARRIER ENVELOPE.

1.3.7 Air Leakage Rate

The rate of airflow (L/s(CFM)) driven through a unit surface area (sq. m(sq.ft.)) of an assembly or system by a unit static pressure difference (Pa) across the assembly. (example: 1.27 L/s-m^2(0.25 CFM/sq.ft.) @ 75 Pa)

1.3.8 Air Leakage

The total airflow (L/s(CFM)) driven through the air barrier system by a unit static pressure difference (Pa) across the air barrier envelope. (example: 3070 L/s (6500 CFM) @ 75 Pa)

1.3.9 Air Permeance

The rate of airflow (L/s(CFM)) through a unit area (sq. m(sq.ft.)) of a material driven by unit static pressure difference (Pa) across the material (example: 0.02 L/s-m^2 (0.004 CFM/sq.ft.) @ 75 Pa).

1.3.10 Environmental Separator

The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. Also known as the Control Layer.

1.4 PREPARATORY PHASE OR PRECONSTRUCTION CONFERENCE

Organize pre-construction conferences between the air barrier inspector and the sub-contractors involved in the construction of or penetration of the air barrier system to discuss where the work of each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials. Discuss the products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance

to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Mock-Up; G[, [_____]]

Build one as specified prior to building construction.

SD-06 Test Reports

Design Review Report; G, DO

[Two] [_____] copies not later than [14] [_____] days after approval of the Air Barrier Inspector Qualifications.

Testing and Inspection; G, RO

SD-07 Certificates

Air Barrier Inspector; G, RO

[Two] [_____] copies 30 days after Notice to Proceed.

[1.6 AIR BARRIER ENVELOPE SURFACE AREA AND LEAKAGE REQUIREMENTS

The building air barrier systems must meet the following leakage requirements. The allowable leakage rate and the maximum leakage are at a differential test pressure of 75 Pa.

Air Barrier Envelope 1	
Surface Area	[_____] square meter square feet
Architectural Only Test:	
Allowable leakage rate	[1.27][2.03][_____] L/s per square meter[0.25][0.40][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM
Architectural Plus HVAC System Test:	
Allowable leakage rate	[1.52][2.29][_____] L/s per square meter[0.30][0.45][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM

Air Barrier Envelope 2	
Surface Area	[_____] square meter square feet

Architectural Only Test:	
Allowable leakage rate	[1.27][2.03][_____] L/s per square meter[0.25][0.40][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM
Architectural Plus HVAC System Test:	
Allowable leakage rate	[1.52][2.29][_____] L/s per square meter[0.30][0.45][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM

Air Barrier Envelope 3	
Surface Area	[_____] square meter square feet
Architectural Only Test:	
Allowable leakage rate	[1.27][2.03][_____] L/s per square meter[0.25][0.40][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM
Architectural Plus HVAC System Test:	
Allowable leakage rate	[1.52][2.29][_____] L/s per square meter[0.30][0.45][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM

][1.7 AIR BARRIER INSPECTOR

Employ a designated Air Barrier Inspector on this project. The Air Barrier Inspector performs a Design Review, oversees quality control testing specified in these specifications, performs quality control air barrier inspection as specified, interfaces with the designer and product manufacturer's representatives to assure all installation requirements are met, and coordinates efforts between all workers installing or penetrating the air barrier materials. Qualification for the Air Barrier Inspector are as follows:

a. Training and certification as an Air Barrier Installer from the Air Barrier Association of America (ABAA) or other third party air barrier association.

b. Experience coordinating and instructing personnel involved in the installation, joining, and sealing of air barrier materials and components.

][1.8 DESIGN REVIEW

Review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the construction of an effective air barrier system. Provide a Design Review Report

individually listing each deficiency and the corresponding proposed corrective action necessary for proper air barrier system.

]PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 QUALITY CONTROL

3.1.1 Documentation and Reporting

Document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.

[3.1.2 Construction Mock-Up

a. Prepare a construction mock-up to demonstrate proper installation of the air barrier assemblies and components. Include air barrier system connections between floor and wall, wall and window, wall and roof. Also, include the sealing method between membrane joints at transitions from one material or component to another, at pipe or conduit penetrations of the wall and roof, and at duct penetration of the wall and roof. Work will not begin until the mock-up is satisfactory to the Contracting Officer.

b. Size the mock-up to approximately 2 m long by 2 m high (8 feet long by 8 feet high). The mock-up must be representative of primary exterior wall assemblies and glazing components including backup wall and typical penetrations as acceptable to the Contracting Officer. A corner of the actual building may be used as the mock-up.

c. Mock-Up Tests for Adhesion: Test the mock-up of materials for adhesion in accordance with manufacturer's recommendations. Perform the test after the curing period recommended by the manufacturer. Record the mode of failure and the area which failed in accordance with ASTM D4541. When the air barrier material manufacturer has established a minimum adhesion level for the product on the particular substrate, the inspection report must indicate whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product/substrate combination, simply record the value.

]3.1.3 Quality Control Testing And Inspection

Conduct the following tests and inspections as applicable in the presence of the Contracting Officer during installation of the air barrier system, and submit quality control reports as indicated below.

a. Provide a Daily Report of Observations with a copy to the Contracting Officer.

b. Inspect to assure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

c. Inspect to assure structural support of the air barrier system to withstand design air pressures.

d. Inspect to assure masonry surfaces receiving air barrier materials are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

e. Inspect and test to assure site conditions for application temperature, and dryness of substrates are within guidelines.

f. Inspect to assure substrate surfaces are properly primed if applicable and in accordance with manufacturer's instructions. Priming must extend at least 2 inches beyond the air barrier material to make it obvious that the primer was applied to the substrate before the air barrier material.

g. Inspect to asure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied in accordance with manufacturer's recommendations, and with no fishmouths.

h. Inspect to assure that a roller has been used to enhance adhesion. Identify any defects such as fishmouths, wrinkles, areas of lost adhesion, and improper curing. Note the intended remedy for the deficiencies.

i. Measure application thickness of liquid applied materials to assure that manufacturer's specifications for the specific substrate are met.

j. Inspect to assure that the correct materials are installed for compatibility.

k. Inspect to assure proper transitions for change in direction and structural support at gaps.

l. Inspect to assure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

m. Perform adhesion tests for fluid-applied and self-adhered air barrier membranes to assure that the manufacturer's specified adhesion strength properties are met. Determine the bond strength of coatings to substrate in accordance with ASTM D4541.

n. Provide cohesion tests for spray polyurethane foam (SPF). [Perform the tests in accordance with the specification sections which specify these materials.] [Perform adhesion tests as follows: Using a coring tool remove a sample and determine the relative adhesion quality of the foam. If the foam is hard to remove and leaves small bits of foam on the substrate it is called cohesive foam failure and is considered the best adhesion. If the foam comes away from the substrate with some force but is clean, it is called a mechanical bond. If it comes away easily from the substrate, the adhesion is poor. Cohesive foam failure and a good mechanical bond are acceptable.]

o. Provide written test reports of all tests performed.

3.2 REPAIR AND PROTECTION

Upon completion of inspection, testing, sample removal and similar services, repair damaged construction and restore substrates, coatings and finishes. Protect construction exposed by or for quality control service activities, and protect repaired construction.

-- End of Section --

PART 1.0 - GENERAL

1.1 REFERENCES: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. All publications shall be the latest in effect on the date of solicitation. The Contractor shall comply with all Federal, State, and local regulations.

SG-76	(AISI) Cold Formed Steel Design Manual
ASTM A792	Steel Sheet, Aluminum-Zinc Alloy-Coated by the Hot Dip Process
ASTM C518	Steady-State, Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D52	Specular Goss
ASTM E96	Water Vapor Transmission of Materials
UL 580	Tests for Uplift Resistance of Roof Assemblies
NRCA	Roofing Manual
SMACNA	Architectural Sheet Metal Manual

1.2 GENERAL: Contract drawings indicate the extent and general assembly details of the metal roofing members and connections not indicated on the drawings shall be designed by the Contractor. All roofing panels, components, transitions and assemblies shall be the product of the same manufacturer. Roofing shall be designed to provide the minimum section properties shown. Roofing shall comply with UL wind uplift Class 90 requirements as defined in UL 580. Steel covering shall be designed in accordance with AISI SG-673.

1.3 SUBMITTALS: Provide detail drawings to consist of catalog cuts, design and erection drawings and other data necessary to clearly describe design, materials, sizes, layouts, construction details, fasteners and erection. Detail drawings shall be accompanied by engineering design calculations for the structural properties of the roofing units. Section modulus and moment of inertia of steel shall be determined in accordance with AISI-01.

1.4 SAMPLES AND DESCRIPTIVE DATA: The following shall be submitted for approval:

1.4.1 Accessories: One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.
1.4.2 Roof Covering: One piece of each type to be used, 9 inches long, full width.
1.4.3 Fasteners: Two samples of each type to be used, with statement regarding intended use.
1.4.4 Gaskets and Insulating Compounds: Descriptive data.
1.4.5 Sealant: One sample, approximately one (1) pound and descriptive data.
1.4.6 Certificates shall attest that roof assembly complies with the material and fabrication requirements specified and is suitable for the installation at the indicated design slope.

1.5 QUALITY ASSURANCE: Fabricator of the metal roofing shall have a minimum of ten (10) years of successful experience in fabricating metal roofing of the required type and size. Contractor shall have a minimum of two (2) years of successful experience in installing the required metal roofing system.

1.6 DELIVERY AND STORAGE: Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weather-tight

coverings and kept dry. Storage accommodations for the metal roof system materials shall provide good air circulation and protection from surface staining.

PART 2.0 - PRODUCTS

2.1 STANDING SEAM ROOF COVERING PANELS: Metal roofing system shall be as manufactured by one of the following or equal. ALL standing seam metal roof system components shall be from a single source:

2.1.2 MBCI Metal Roof and Wall Systems, Houston, Texas

2.2 INSULATED ROOF PANELS: BATTEN LOK METAL ROOF PANELS 24 GA 12" WIDE Roof panels shall be factory roll-formed, 18 inches wide, with two (2) major corrugations, 2 inches high minimum, 18 inches on center, MBCI Double-Lok or equal, dark bronze color to match base-wide standing seam metal roof standard. Provide Energy Star qualified "cool" color.
Roof Panel rigid Insulation = R30

2.2.1 Panel material as specified shall be 24 gauge steel coated both sides with a layer of aluminum-zinc alloy applied by the continuous hot dip method; minimum 0.55 ounce coated weight per square foot as determined by the triple spot test per ASTM A 792. Exposed panel finish shall be equal to a film thickness of 0.70 mil (minimum) Kynar 500/Hylar 5000 fluorpolymer coating. Bottom side of panel shall be coated with a primer with a dry film thickness of 0.25 mil.

2.2.2 Panels of maximum possible lengths shall be used to minimize end laps. Eave panels shall extend beyond the structural line of the sidewall.

2.2.3 Panels shall be factory pre-punched at panel end to match pre-punched holes in the eave structure member. Panel end splices shall be factory pre-punched and pre-holed. Panel end splices shall be floating and allow the roof panels to expand and contract with roof panel temperature changes.

2.2.4 Ridge assemblies shall be designed to allow roof panels to move lengthwise with expansion/contraction as the roof panel temperature changes. Parts shall be factory pre-punched for correct field assembly. Panel closures and interior reinforcing straps shall be installed to seal the panel ends at the ridge. The attachment fasteners shall not be exposed on the weather side. A lock-seam plug shall be used to seal the lock-seam portion of the panel. A high-tensile steel ridge cover shall span from panel closure to panel closure and flex as the roof system expands and contracts.

2.2.5 Entire roof shall be covered with "Underlayment A or B" as specified in Section 07311 prior to roof panel installation. Underlayment shall be inspected & approved by Contracting Official prior to covering. Refer to each individual building bid schedule.

2.2.6 Exposed Fasteners: Refer to Section 07710.

PART 3.0 - EXECUTION

3.1 The roof panel shall not be considered to be a safe work platform until completely secured to the existing roof structural system. Therefore, walk boards or other safety equipment as required by safety standards shall be provided by the erecting contractor to provide worker safety during panel installation.

3.2 PANEL INSTALLATION

3.2.1 All panel clips shall be positioned by matching the hole in the clip with the pre-punched holes in the secondary structural members.

3.2.2 All panels shall be positioned and properly aligned by matching the pre-punched holes in the panel end with the pre-punched holes in the eave structural member and by aligning the panel with the panel clip.

3.2.3 Panel side laps shall be field-seamed by a self-propelled and portable electrical lock seaming machine. The machine field forms the final 180 degrees of a 360 degree Pittsburgh double-lock standing seam; all side laps sealant shall be factory applied.

3.2.4 Panel end laps, when required, shall be at least size (6) inches, sealed with manufacturer's sealants and fastened together by clamping plates. Sealants shall contain hard nylon beads which prevent mastic from flowing out due to clamping actions. The panel laps shall be joined by a means of a two-piece clamped connection consisting of a bottom reinforcing plate and a top panel strap. The panel end laps shall be located directly over, but not fastened to, a supporting secondary roof structural member and be staggered so as to avoid a four panel lap splice condition.

3.3 FASTENER COMPONENTS

3.3.1 All connections of roof panels to existing roof, except at eave, shall be made with clips with moveable stainless steel tabs that are seamed into the standing seam lap side.

3.3.2 Panel clips shall be fastened to existing roof with "Scrubolt" (or equal) fasteners as per manufacturer's erection drawings, using factory pre-punched holes in structural members. Fasteners shall contain a metal backed rubber washer which serves as a torque indicator.

3.3.3 Panel to panel connections shall be made with positive, field-formed standing double-lock seam, formed by a seaming machine. The machine field forms the final 180 degrees of a 360 degree Pittsburgh double-lock standing seam; all side lap sealant shall be factory applied.

3.3.4 Fasteners penetrating the metal membrane at the following locations do not exceed the frequency listed:

Basic Panel System	0 per square foot	High Eave (no parapet)	2/linear foot
Exterior Eave Gutter	2 per lineal foot	Panel Splices	2/linear foot
Gable Trim (no parapet)	2 per lineal foot	High Side Transition	1/linear foot
Ridge	1/linear foot		

3.4 ROOF ACCESSORIES

3.4.1 Accessories shall be as standard with Roof System manufacturer unless otherwise indicated and furnished as specified.

3.4.2 Location of standard accessories shall be as shown on erection drawings as furnished by the manufacturer.

3.4.3 Material used in flashing and transition parts and furnished as standard by the manufacturer shall match the roof panel material. Parts shall be compatible and shall not cause a corrosive condition. Copper and lead materials shall **NOT** be used with this roof system.

3.5 EXPANSION/CONTRACTION

3.5.1 Provisions for thermal expansion movement of the panels shall be accomplished by use of clips with a movable tab. The tabs shall be factory centered on the roof clip when installed to assure full movement in either direction. A force of no more than eight (8) pounds will be required to initiate tab movement. Each clip shall accommodate a minimum of 1.25 inches in either direction.

3.5.2 The roof shall provide for thermal expansion/contraction without detrimental effect on the roof panel when there is a plus or minus 100 degrees, based upon temperature differences between the inside structural framework of the building and the temperature of the roof panels.

3.6 INCIDENTAL ITEMS

Provide all incidental items required for complete, fully functional installation of standing seam metal roof system, including removal of any existing materials that interfere with installation of the standing seam metal roof system, including existing roof; temporary weather-proofing; fasteners; closure strips, and transition pieces.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless other wise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN ARCHITECTURAL MANUFACTURER'S ASSOCIATION (AAMA)

a. AAMA 501.1 Methods of Tests for Exterior Walls

1.1.1.2 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

a. AISC 341 Seismic Provisions for Structural Steel Buildings

1.1.1.3 AMERICAN IRON AND STEEL INSTITUTE (AISI)

a. AISI SG03-3 Cold Formed Steel Design Manual Set

1.1.1.4 AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

a. ASCE 7 Minimum Design Loads for Buildings and Other Structures

1.1.1.5 AMERICAN WELDING SOCIETY (AWS)

a. AWS A5.1 Carbon Steel Electrodes for Shielded Metal Arc Welding

b. AWS D1.1 Structural Welding Code – Steel

1.1.1.6 ASTM INTERNATIONAL (ASTM)

a. ASTM A 1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength, Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened

b. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

c. ASTM A 36 Standard Specification for Carbon Structural Steel

d. ASTM A 424 Standard Specification for Steel Sheet for Porcelain Enameling

e. ASTM A 463 Standard Specification for Steel Sheet, Aluminum-Coated

f. ASTM A 606 Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy,

g. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

h. ASTM A 755 Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products

i. ASTM A 780 Standard Practice for Repair of Damaged and non-coated areas of Hot-Dip Galvanized Coatings

j. ASTM A 792	Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
k. ASTM A 924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
l. ASTM B 117	Standing Practice for Operating Salt Spray (Fog) Apparatus
m. ASTM B 209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
n. ASTM C 273	Shear Properties of Sandwich Core Materials
o. ASTM C 286	Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems
p. ASTM C 553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
q. ASTM C 612	Mineral Fiber Block and Board Thermal Insulation
r. ASTM C 920	Standard Specification for Elastomeric Joint Sealants
s. ASTM D 1056	Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
t. ASTM D 1308	Effect of Household Chemicals on Clear and Pigmented Organic Finishes
u. ASTM D 1621	Compressive Properties of Rigid Cellular Plastics
v. ASTM D 1622	Apparent Density of Rigid Cellular Plastics
w. ASTM D 1667	Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
x. ASTM D 2244	Standard Test Method for Mean Molecular Weight of Mineral Insulating Oils by the Cryoscopic Method
y. ASTM D 2247	Testing Water Resistance of Coatings in 100% Relative Humidity
z. ASTM D 2794	Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
aa. ASTM D 2856	Open-Cell Content of Rigid Cellular Plastics by the Air Pycnometer
bb. ASTM D 3363	Film Hardness by Pencil Test
cc. ASTM D 4214	Evaluating the Degree of Chalking of Exterior Paint Films
dd. ASTM D 522	Mandrel Bend Test of Attached Organic Coatings
ee. ASTM D 714	Evaluating Degree of Blistering of Paints
ff. ASTM D 822	Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
gg. ASTM D 968	Abrasion Resistance of Organic Coatings by Falling Abrasive
hh. ASTM E 119	Standard Test Methods for Fire Tests of Building Construction and Materials

ii.	ASTM E 136	Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
jj.	ASTM E 1592	Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
kk.	ASTM E 283	Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ll.	ASTM E 331	Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
mm.	ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
nn.	ASTM G 23	Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

1.1.1.7 METAL BUILDING MANUFACTURER'S ASSOCIATION (MBMA)

a.	MBMA MBSM	Metal Building Systems Manual

1.1.1.8 NATIONAL ASSOCIATION OF ARCHITECTURAL METALS ASSOCIATION (NAAMM)

a.	NAAMM AMP 500	Metal Finished Manual

1.1.1.9 PORCELAIN ENAMEL INSTITUTE (PEI)

a.	PEI 1001	Specification for Architectural Porcelain Enamel (ALS-100)
b.	PEI CG-3	Color Guide For Architectural Porcelain Enamel

1.1.1.10 SHEET METAL AND AIR CONDITIONING CONTRACTOR'S NATIONAL ASSOCIATION (SMACNA)

a.	SMACNA ARCH MAN.	Architectural Sheet Metal Manual

1.1.1.11 THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

a.	SSPC PAINT 12	Paint Specification No. 12 Cold-Applied Asphalt Mastic (Extra Thick Film)

1.1.1.12 UNDERWRITERS LABORATORIES (UL)

a.	UL 580	Tests for Uplift Resistance of Roof Assemblies
b.	UL Bld Mat Dir	Building Materials Directory

1.2 DEFINITIONS

1.2.1 Fabricated Wall Panel Assembly: Metal wall and liner panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories shop fabricated or field assembled for a complete weather-tight wall system.

1.3 DESCRIPTION OF FABRICATED WALL PANEL ASSEMBLY SYSTEM

1.3.1 Factory color finished metal wall panel system with concealed fastening attachment. Panel profile must be as indicated or required. Interior finish of panel assembly to be as indicated or required.

1.3.2 Metal Wall Panel General Performance

1.3.2.1 Comply with performance requirements, conforming to AISI/COS/NASPEC, without failure due to defective manufacture, fabrication, installation, or other defects in construction. Wall panels and accessory components must conform to the following standards:

a. ASTM A 1008
b. ASTM A 123
c. ASTM A 36
d. ASTM A 653
e. ASTM A 463 for aluminum coated steel sheet
f. ASTM A 606
g. ASTM A 755 for metallic coated steel sheet for exterior coil pre-painted applications
h. ASTM A 780 for repair of damage or uncoated areas of hot-dipped
i. ASTM A 924 for metallic coated steel sheet
j. ASTM C 273
k. ASTM D 522 for applied coatings
l. UL Bld Mat Dir

1.3.3 Structural Performance

1.3.3.1 Maximum calculated fiber stress must not exceed the allowable value in the AISI or AA manuals; a one third overstress for wind is allowed. Midspan deflection under maximum design loads is limited to L/180. Contract drawings show the design wind loads and the extent and general assembly details of the metal siding. Contractor must provide design for members and connections not shown on the drawings. Siding panels and accessories must be the products of the same manufacturer.

1.3.3.2 Provide metal wall panel assemblies complying with the load and stress requirements in accordance with ASTM E 1592. Wind Load force due to wind action governs the design for panels.

1.3.3.3 Wall systems and attachments are to resist the wind loads as determined by UL 580 and ASCE/SEI 7-05 in the geographic area where the construction will take place, in pounds per square foot. Submit electronic copies of wind load tests and to the Contracting Officer on AF3000.

1.3.3.4 Provide metal wall panel assembly for seismic conditions complying with the applicable requirements of AISC 341.

1.3.4 Air Infiltration

1.3.4.1 Air leakage must conform to the limits through the wall assembly area when tested according to ASTM E 283.

1.3.5 Water Penetration Under Static Pressure

1.3.5.1 No evidence of water leakage when tested according to AAMA 501.1.

1.4 SUBMITTALS

1.4.1 Government approval may be required on any of the following items.

1.4.1.1 SD-01 Pre-Construction Submittals

a. Qualification of Manufacturer

b. Qualification of Installer

c. Qualifications for Welding

1.4.1.2 SD-02 Shop Drawings

a. Fabrication and Installation drawings for the following items are to indicate completely dimensioned structural frame and erection layouts, openings in the wall, special framing details, and construction details at corners, building intersections and flashing, location and type of mastic and metal filler strips.

b. Wall Panels

c. Flashing and Accessories

d. Anchorage Systems

1.4.1.3 SD-03 Product Data

a. Submit Manufacturer's data indicating percentage of recycle material in wall panels to verify sustainable acquisition compliance.

b. Submit Manufacturer's catalog data for the following items:

(1) Factory Color Finish

(2) Sub Girts and Formed Shapes

(3) Closure Materials

(4) Insulation

(5) Pressure Sensitive Tape

(6) Sealants and Caulking

(7) Rated Wall Assembly

(8) Galvanizing Repair Paint

(9) Enamel Repair Paint

(10) Aluminized Steel Repair Paint

(11) Accessories

1.4.1.4 SD-04 Samples

a. Submit as required each of the following samples:

(1) Wall Panel Assemblies, 12 inches long by actual panel width

(2) Fasteners

(3) Metal Closure Strips, 10 inches long

(4) Each type of insulation, approximately 8 by 11 inches.

a. Submit manufacturer's color charts and chips, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

1.4.1.5 SD-05 Design Data

a. Design Calculations

b. Wind Resistance

(1) Engineering calculations comparing wind uplift calculations with tested wind resistance. Calculations shall be prepared, signed, and sealed by a registered structural engineer.

1.4.1.6 SD-06 Test Reports

a. Submit test reports for the following in accordance with the requirements in this section:

(1) Leakage Test

(2) Fire Rating Test Report

(3) Coatings and base metals of metal wall test as specified and in various referenced standards in this section.

(4) Factory Finish and Color Performance Requirements

1.4.1.7 SD-07 Certificates

a. Submit certificates for the following items showing conformance with referenced standards contained in this section:

(1) Fasteners

(2) Galvanizing Repair Paint

(3) Enamel Repair Paint

b. Provide evidence that products used within this specification are manufactured in the United States.

c. Qualification of Manufacturer

(1) Certify that the manufacturer of the metal wall panel system meets requirements specified under paragraph entitled "Qualification of Manufacturer.”

d. Qualification of Installer

(1) Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Installation Contractor.

e. Submit the wall system assembly wind load and fire rating classification listings.

1.4.1.8 SD-08 Manufacturer’s Instructions

a. Installation of Wall Panels

(1) Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

1.4.1.9 SD-11 Closeout Submittals

a. Warranties

(1) Finish Warranty

(2) Leak Free 20 Year Warranty

a. Instruction to Government Personnel for maintenance/repair materials. Include MSDS information for all products.

1.5 QUALITY ASSURANCE

1.5.1 Pre-Installation Conference

1.5.1.1 After approval of submittals and before performing wall panel system installation work, hold a pre-installation conference to review the following:

a. The drawings, including Fabrication and Installation drawings, showing complete Wall Panel Assemblies, and specifications. Include details for the following for review:

(1) Flashings and Accessories

(2) Anchorage Systems

(3) Manufacturer’s Catalog Data

(4) Factory Color Finish

(5) Submit manufacturer's color charts and chips, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

(6) Sub-girts and Formed Shapes

(7) Closure Materials, including metal closure strips

(8) Insulation

(9) Pressure Sensitive Tape

(10) Rated Wall Assembly test data

(11) Accessories

(12) Fasteners

b. Finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal wall panel installation, including manufacturer's written instructions for Installation of Wall Panels, and verification of wall system assembly wind load and fire rating classification listings.

d. Support conditions for compliance with requirements, including alignment between and attachment to structural members. Provide details of wind design analysis including wind speed, exposure category, co-efficient, importance factor, designates type of facility, negative pressures for each zone, methods and requirements of attachment. Wind design analysis to include wall plan delineating dimensions and attachment patterns for each zone. Wind design analysis to be prepared and sealed by Licensed Project Engineer in the geographic area where the construction will take place.

e. Flashing, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.

f. Governing regulations and requirements for insurance, certificates, tests and inspections if applicable. Include certification for sustainable acquisition and wall system assembly wind load and fire rating classification. Safety plan review must include applicable Material Safety Data Sheets.

g. Temporary protection requirements for metal wall panel assembly during and after installation.

h. Wall panel observation and repair procedures after metal wall panel installation. Include review of sample Repair Paint.

i. Sample 20 year "No-Dollar-Limit" warranty.

1.5.2 Manufacturer's Technical Representative

1.5.2.1 The representative shall have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and with installations in the geographical area where construction will take place. The manufacturer's representative shall be an employee of the manufacturer with at least 5 years experience in installing the wall system. The representative shall be available to perform field inspections and attend meetings as required herein, and as requested by the Contracting Officer.

1.5.3 Installer’s Qualifications

1.5.3.1 The wall system installer shall be factory-trained, approved by the metal wall system manufacturer to install the system, and shall have a minimum of three years experience as an approved applicator with that manufacturer. The applicator shall have applied five installations of similar size and scope as this project within the previous 5 years.

1.5.4 Manufacturer

1.5.4.1 The wall panel shall be the product of a metal wall industry - recognized manufacturer who has been in the practice of manufacturing pre-fabricated wall panels for a period of not less than 5 years and who has been involved in at least 5 projects similar in size and complexity to this project.

1.5.5 Single Source

1.5.5.1 Wall panels, clips, closures, and other accessories shall be standard products of the same manufacturer; shall be the latest design by the manufacturer; and shall have been designed by the manufacturer to operate as a complete system for the intended use.

1.5.6 Surface Burning Characteristics

1.5.6.1 Provide metal wall panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.

b. Smoke-Developed Index: 450 or less.

1.5.7 Fire Resistance Ratings

1.5.7.1 Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5.7.2 Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency. Combustion Characteristics: ASTM E 136.

1.5.8 Fabrication

1.5.8.1 Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles, dimensional and structural requirements conforming to AISI SG03-3.

1.5.8.2 Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

1.5.8.3 Fabricate metal wall panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

1.5.8.4 Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated.

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA 1793.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA 1793 or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

1.5.9 Finishes

1.5.9.1 Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

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

1.6 DELIVERY STORAGE AND HANDLING

1.6.1 Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed; package metal wall panels for protection during transportation and handling. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

1.6.2 Stack metal wall panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering; store metal wall panels to ensure dryness. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

1.6.3 Protect strippable protective covering on metal wall panels from exposure to sunlight and high humidity, except to extent necessary for period of metal wall panel installation.

1.6.4 Protect foam-plastic insulation as follows:

1.6.4.1 Do not expose to sunlight, except to extent necessary for period of installation and concealment.

1.6.4.2 Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

1.6.5 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 PROJECT CONDITIONS

1.7.1 Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal wall panel work to proceed without water entering the building.

1.7.2 Field Measurements: Verify actual dimensions of construction contiguous with metal wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

1.8.1 Furnish manufacturer's no-dollar-limit warranty for the metal wall panel system. The warranty period is to be no less than twenty (20) years from the date of Government acceptance of the work. The warranty is to be issued directly to the Government. The warranty is to provide that if within the warranty period the metal wall panel system shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the wall panel system resulting from defective materials and correction if the defective workmanship is to be the responsibility of the metal wall panel system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal wall panel system is under warranty are to be performed within 24 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

1.8.2 Continuance of Warranty

1.8.2.1 Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the wall

system assembly and validity of the metal wall system manufacturer warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 PANEL MATERIALS

2.2 MBCI – Insulated Metal Panel System: cf-36 tuff wall (2" thick)

2.2.1 Steel Sheet (single sheets to be used inside Blasting Work Shop and Paint Work Shop)

2.2.1.1 Roll-form steel wall and liner panels to the specified profile, gauge and depth as indicated or required, conforming to ASTM A 1008/A 1008M, ASTM A 36/A 36M. Material must be plumb and true, and within the tolerances listed:

a. Galvanized/Galvannealed Steel Sheet conforming to ASTM A 123/A 123M, ASTM A 653/A 653M, ASTM A 653/A 653M, ASTM A 653/A 653M, ASTM A 792/A 792M, and AISI SG03-3.

b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A 463/A 463M, ASTM A 792/A 792M and AISI SG03-3.

c. Steel sheet with porcelain coating conforming to ASTM A 424, ASTM C 286, and PEI 1001, or ASTM A 606 for improved atmospheric corrosion resistance.

d. Individual panels to have continuous length to cover the entire length of any unbroken area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

e. Provide panels with thermal expansion and contraction consistent with the type of system specified.

f. Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated wall area.

2.2.2 Foam Insulation Core Wall Panel

2.2.2.1 Provide factory-formed steel wall panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core foamed-in-place or board during fabrication with joints between panels designed to form weather-tight seals as indicated or required. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D 2856.

b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D 1622.

c. Compressive Strength: Minimum 20 psi when tested according to ASTM D 1621.

d. Shear Strength: 26 psi when tested according to ASTM C 273.

2.2.3 Insulated Panel Construction

2.2.3.1 Shop fabricate or field assemble insulated panel construction with specified steel sheet in accordance with manufacturer's printed instructions and as indicated or required.

2.2.3.2 Single sheet metal panels to be installed at interior of Blast Work Shop and Paint Workshop as

indicated in drawings.

2.2.3.3 Insulation to be 2” rigid glass-fiber conforming to ASTM C 553 and ASTM C 612 of thickness and density as required for the geographical area where construction will take place. Glass-Fiber is a material listed in the EPA's Comprehensive Procurement Guidelines.

2.2.3.4 Insulation fasteners to be adhesively attached, plate welded to projecting spindle anchors; capable of holding insulation of thickness indicated, secured in position with self-locking washer and complying with the following requirements:

a. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

b. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

d. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

2.2.4 Finish

2.2.4.1 All panels, trim, & flashing are to receive a factory-applied polyvinylidene fluoride, Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer s recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 4.1 mils 4.00 + 0.10 mils for Vinyl Plastisol. This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.6 mils for a total dry film thickness of 0.50 + 0.10 mils. The wash-coat must be oven-cured.

e. Color: The exterior finish chosen from the manufacturer's standard color chart.

f. Physical Properties: Coating must conform to the industry and manufacturer s standard performance criteria as listed by the following certified test reports:

(1) Chalking: ASTM D 333

(2) Coating Thickness: ASTM B 659

(3) Color Change and Conformity: ASTM D 2244

(4) Weatherometer: ASTM G 23 and ASTM D 822

(5) Humidity: ASTM D 2247 and ASTM D 714

(6) Salt Spray: ASTM B 117

(7) Chemical Pollution: ASTM D 1308

(8) Gloss at 60: ASTM D 523

(9) Pencil Hardness: ASTM D 3363

(10) Reverse Impact: ASTM D 2794

(11) Flexibility: ASTM D 522

(12) Abrasion: ASTM D 968

(13) Flame Spread: ASTM E 84

2.3 MISCELLANEOUS METAL FRAMING

2.3.1 General

2.3.1.1 Cold-formed metallic-coated steel sheet conforming to AISI SG03-3 and ASTM A 653 and specified in Section 05 40 00 Cold-Formed Metal Framing unless other wise indicated.

2.3.2 Fasteners for Miscellaneous Metal Framing

2.3.2.1 Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the wall panel manufacturer's and ASCE/SEI 7-05 requirements

2.4 FASTENERS

2.4.1 General

2.4.1.1 Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the wall panel manufacturer's and ASCE/SEI 7 requirements.

2.4.2 Exposed Fasteners

2.4.3 Fasteners shall be the manufacturer's standard zinc-coated steel, corrosion resistant steel, or nylon capped steel. Exposed fasteners shall be “long life” shielded gasket washers on the exterior side of the covering to waterproof the penetration, ZXL SteelBinder or equal. Washer material shall be compatible with the covering and have a minimum diameter of 3/8 inch. Gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Fasteners used for structural connectors and concealed clips shall be sized and spaced in order to provide a UL wind classification class 90 rating when tested in accordance with UL 580, to ensure structural integrity of the roofing system. Exposed rivets shall be closed-end type where watertight connections are required. **Exposed fasteners shall match the surrounding material in color.**

2.4.4 Attachment Clips

2.4.4.1 Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A 653/A 653M Z275 G 90 or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.5 ACCESSORIES

2.5.1 General

2.5.1.1 All accessories to be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.5.2 Rubber Closure Strips

2.5.2.1 Closed-cell, expanded cellular rubber conforming to ASTM D 1056 and ASTM D 1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

2.5.3 Metal Closure Strips

2.5.3.1 Factory fabricated steel closure strips to be the same material, gauge, color, finish and profile of the specified wall panel.

2.5.4 Joint Sealants

2.5.4.1 Sealants

a. Sealants are to be an approved gun type for use in hand- or air-pressure calking guns at temperatures above 40 degrees F with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

b. Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

2.5.4.2 Shop Applied

a. Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C 920, Type II, and with a curing time to ensure the sealant s plasticity at the time of field erection.

2.5.4.3 Field Applied

a. Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C 920, Type II. Color to match panel colors.

2.5.4.4 Tape Sealant

a. Pressure sensitive, 100% solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.6 SHEET METAL FLASHING AND TRIM

2.6.1 Fabrication, General

2.6.1.1 Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal and other characteristics of the items indicated. Shop fabricated items where practicable. Obtain field measurements for accurate fit before shop fabrication.

2.6.1.2 Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems. No cut edges shall be exposed unless approved by CO.

2.7 REPAIR OF FINISH PRODUCTS

2.7.1 Repair paint for color finish enameled wall panel must be compatible paint of the same formula and color as the specified finish furnished by the wall panel manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Contracting Officer may request verification and certification testing of coatings and base metals of metal wall panel prior to installation.

3.1.1.1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.

3.1.1.2 Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer, UL, ASTM, ASCE/SEI 7-05 and as required for the geographical area where construction will take place.

3.1.1.3 Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

3.1.1.4 Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

3.1.1.5 Submit to the Contracting Officer a written report, endorsed by Installer, listing conditions detrimental to performance of the work.

3.1.1.6 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

3.2.1 Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

3.2.2 Miscellaneous Framing: Install sub-purlins, eave angles, furring, and other miscellaneous wall panel support members and anchorage according to metal wall panel manufacturer's written instructions.

3.3 METAL WALL PANEL INSTALLATION

3.3.1 Provide metal wall panels of full length from sill to eave, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement in accordance with MBMA Metal Building Systems Manual.

3.3.1.1 Steel Wall Panels: Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

3.3.1.2 Anchor Clips: Anchor metal wall panels and other components of the work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.3.1.3 Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating conforming to SSPC Paint 12, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

3.3.1.4 Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

3.3.2 Erect metal wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

3.3.3 Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets must not be applied.

3.3.4 Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated sill and eave.

3.3.5 Work is to allow for thermal movement of the wall, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

3.3.6 Field cutting metal wall panels by torch is not permitted.

3.4 FASTENER INSTALLATION

3.4.1 Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.5 FLASHING TRIM AND CLOSURE INSTALLATION

3.5.1 General Requirements

3.5.1.1 Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and

level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.5.1.2 Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

3.5.2 Metal Flashing

3.5.2.1 Exposed metal flashing is to be installed at building corners, sills and eaves, junctions between metal siding and walling.

3.5.2.2 Exposed metal flashing is to be the same material, color, and finish as the specified metal wall panel.

3.5.2.3 Flashing is to be fastened at not more than 8 inches on center, except where flashing are held in place by the same screws that secure covering sheets.

3.5.2.4 Flashing is to be furnished in at least 8-foot lengths. Exposed flashing is to have one inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 16 feet.

3.5.2.5 Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

3.5.2.6 Flashing which is in contact with dissimilar metals to be isolated by means of the specified asphalt mastic material to prevent electrolytic deterioration.

3.5.2.7 Drips to be formed to the profile indicated, with the edge folded back 1/2 inch to form a reinforced drip edge.

3.5.3 Closures

3.5.3.1 Install metal closure strips at open ends of metal ridge rolls; open ends of corrugated or ribbed pattern walls, and at intersection of wall and wall unless open ends are concealed with formed eave flashing and in other required areas.

3.5.3.2 Install mastic closure strips at intersection of the wall with metal wall; top and bottom of metal siding; heads of wall openings; and in other required locations.

3.6 WORKMANSHIP

3.6.1 Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

3.6.2 Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

3.7 ACCEPTANCE PROVISIONS

3.7.1 Erection Tolerance

3.7.1.1 Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than 1/8 inch in 40 feet.

3.7.2 Leakage Tests

3.7.2.1 Finished application of metal wall panels are to be subject to inspection and test for leakage by the Contracting Officer, Architect/Engineer. Inspection and tests will be conducted without cost to the Government.

3.7.2.2 Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

3.7.3 Repairs to Finish

3.7.3.1 Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of color and surface texture.

3.7.3.2 Repaired metal surfaces that are not acceptable to the project requirements are to be immediately removed and replaced with new material.

3.7.4 Paint-Finish Metal Siding

3.7.4.1 Paint-finish metal wall panels will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

3.7.4.2 Panels that indicate color changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Government.

3.7.4.3 New panels will be subject to the specified tests for an additional year from the date of their installation.

3.8 CLEAN-UP AND DISPOSAL

3.8.1 Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from walls. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, solder or weld marks and damage to the finish coating.

3.8.2 Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

*** END OF SECTION ***

PART 1.0 GENERAL:

1.1 REFERENCES: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. All publications shall be the latest in effect on the date of solicitation. The Contractor shall comply with all Federal, State, and local regulations.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A526	Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process, Commercial Quality
ASTM B370	Copper Sheet and Strip for Building Construction
ASTM B486	Paste Solder
ASTM D2244	Calculation of Color Differences from Instrumentally Measured Color Coordinates

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA	Architectural Sheet Metal Manual.

1.2 GENERAL REQUIREMENTS: Sheet metal work shall be accomplished to form weather-tight construction. Work shall be installed without waves, warps, buckles, fastening stresses or distortion and shall allow for expansion and contraction. Cutting, fitting, drilling and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics. Exposed edges shall be hemmed. Bottom edges of exposed vertical surfaces shall be angled to form drips. Flashing at the end of a run shall be formed into a three dimensional configuration to direct water to the outside of the system. Accessories and other items essential to complete the sheet metal installation, though not specifically indicated or specified, shall be provided. Installation of sheet metal items used in conjunction with roofing shall be coordinated with roofing work to permit continuous roofing operations. Factory fabricated components shall be packed in cartons marked with the manufacturer's name or trademark. Bulk materials from which items are field fabricated shall have manufacturer's name or trademark printed or embossed at frequent intervals to permit easy identification.

1.3 SUBMITTALS: The following shall be submitted in accordance with AF Form 66 and Specification General Requirements Requirements:

Shop Drawings: Provide sheet metal drawings that show weights, gauges, or thickness of sheet metal, type of material, joining, expansion joint spacing, and fabrication details, and installation procedures. Materials shall not be delivered to the site until after the approved detail drawings have been returned to the Contractor.

Samples of materials proposed for use, upon request.

Contractor’s Quality Control for proper size and thickness, fastening and joining, and proper installation. The actual quality control observations and inspections shall be documented and a copy of the documentation furnished to the Contracting Officer at the end of each day.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be adequately packaged and protected during shipment and shall be inspected for damage, dampness, and wet storage stains upon delivery to the jobsite. Materials shall be clearly labeled as to type and manufacturer. Sheet metal items shall be carefully handled to avoid damage. Materials shall be stored in dry, weather-tight, ventilated areas until immediately before installation.

PART 2.0 PRODUCTS

2.1 Materials shall conform to the requirements specified below and those given in TABLE 1. Where TABLE 1 lists more than one metal for a particular item, any listed metal may be used unless otherwise specified. Different items need not be of the same metal.

Fasteners: Fasteners shall be the best type for the application. Provide copper nails and rivets, and bronze screws and bolts when fastening copper fabrications.

Sheet Metals:

a. Galvanized Steel: ASTM A526 with coating designation G90, not chemically treated, not oiled, phosphatized, factory prefinished. Prefinished galvanized steel shall be factory primed and coated with a full strength fluoropolymer containing a minimum of 70% Kynar (or equal) 500 resin. Color shall be a pre-finished coating and shall carry a 20 year manufacturer's warranty against cracking, peeling, blistering, color change in excess of 5 NBS units as measured in accordance with ASTM D 2244, and chalking in excess of 8 as measured in accordance with ASTM D 659. Use ASTM B 486, Alloy 50B, for use with copper and Alloy 60B for use with stainless steel.

b. Copper: ASTM B370, Temper H 00, weight as indicated on drawings. Use Solder: ASTM B486, Alloy 50B.

2.2 SEALANTS AND SEALING COMPOUNDS

Sealants and sealing compounds referred to hereinafter are specified in SECTION 07920 - SEALANTS.

PART 3.0 EXECUTION

3.1 EXAMINATION: Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PROTECTION OF ALUMINUM AND GALVANIZED STEEL: Aluminum and galvanized steel shall not be used where it will be in contact with copper or where it will contact water which flow over copper surfaces. Paint aluminum and galvanized steel that will be in contact with wet or pressure treated wood, mortar, concrete, masonry or ferrous metals to protect against galvanic or corrosive action. Aluminum and galvanized steel surfaces to be protected shall be solvent cleaned and given a coat of zinc chromate primer and one coat of aluminum paint. Aluminum paint shall conform to SECTION 09900 - PAINTING, GENERAL. Non-absorptive tape or gasket shall be placed between the adjoining surfaces and shall be cemented to the aluminum or galvanized steel surface using cement compatible with aluminum or galvanized steel.

3.3 INSTALLATION

3.3.1 General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer’s installation requirements, and SMACNA’s “Architectural Sheet Metal Manual.” Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

3.3.2 Install exposed sheet metal work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal

flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3.3.3 Separations: Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by the manufacturer.

3.4 SOLDERING, RIVETING, SEAMING AND SEALING

3.4.1 Soldering: Soldering shall apply to copper, galvanized steel and stainless steel items. Edges of sheet metals, except lead coated material, shall be pretinned before soldering is begun. Soldering shall be done slowly with well heated soldering irons so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of lead coated material to be soldered shall be scraped or wire brushed to produce a bright surface, and seams shall have a liberal amount of flux brushed in before soldering is begun. Edges of stainless steel to be pretinned shall be treated with soldering acid flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid flux residue shall be thoroughly cleaned from the sheet metal with a solution of washing soda in water and rinsed with clean water.

3.4.2 Damaged Galvanized Coating: Where galvanized coating has been damaged by soldering, damaged areas shall be painted with approved galvanizing repair paint with high zinc dust content.

3.4.3 Riveting and Sealing: Joints in aluminum sheets 0.040 inch or less in thickness shall be made mechanically and sealed with the sealant specified.

3.4.4 Seams: Flat lock and soldered lap seams shall finish not less than 1 inch wide. Unsoldered plain lap seams shall lap not less than 3 inches unless otherwise specified. Flat seams shall be made in the direction of the flow.

3.5 CLEATS: A continuous cleat shall be provided where indicated or specified to secure loose edges of the sheet metalwork. Butt joints shall be spaced approximately 1/8 inch apart. The cleat shall be fastened to the supporting construction with nails/screws evenly spaced not over 12 inches on centers. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry. The cleat for fascia anchorage shall be installed to extend below the supporting construction to form a drip and to allow the flashing to bed hooked over the lower edge at least 3/4 inch. The cleat shall be of sufficient width to provide adequate bearing area to insure a rigid installation. Where horizontal nailer is vented for insulation and the cleat is placed over masonry or concrete, the cleat shall be installed over 1/16 inch thick metal washers placed at screws. Washers shall be of metal that is electrolytically compatible with the continuous cleat.

3.6 FLASHINGS: Flashings shall be installed at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof and floor drains, and for electrical conduit projections through roof or walls is covered in appropriate sections for such work. Corner units shall have mitered joints and shall be installed with three-inch lap joint over flashings on each side. Unless otherwise indicated, through wall flashing shall be terminated 1/2 inch inside each exposed faced of the wall. Perforations in flashings made by masonry anchors shall be covered up by an application of bituminous plastic cement at the perforation.

3.6.1 Extrusions: The extruded type of aluminum gravel stop and fascia shall be factory-fabricated, prepackaged, complete system with fastenings of the style indicated. The system shall be installed in accordance with the manufacturer's recommendations and the other requirements herein specified.

3.6.2 Smooth Sheets: Gravel stops shall be installed with 1/2 inch space between sections. The cover plate shall be embedded in bituminous cement, nailed through the opening between the gravel stop sections and loose locked to the drip edge. The lower edge of fascia shall be hooked 3/4 inch over a continuous cleat and bent outward at an angle of 30 degrees.

3.7 COUNTER-FLASHINGS: Coordinate installation of counter-flashings with installation of assemblies to be protected by counter-flashing. Install counter-flashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counter-flashing joints a minimum of two inches and bed with sealant.

3.8 ROOF-PENETRATION FLASHING: Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashings as follows:

3.8.1 Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.

3.8.2 Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.

3.9 VALLEY FLASHING: Valley flashing shall be free from longitudinal seams and shall be of a width sufficient to extend not less than five inches under the roof covering on each side. The sheets shall not lap less than eight inches in the direction of flow and shall be secured to roofing construction with cleats on each side. Cleats shall be spaced not more than 24 inches on center. The exposed flashing shall not be less than four inches in width. All valley flashings, regardless of roof type, shall be no less than ten (10) inches under roof covering on both sides.

3.8 DOWNSPOUTS: Downspouts shall be set plumb and less than one inch from the wall. Leaders shall connect gutters on overhanging eaves to downspouts. Leaders shall be set with a slope not less than 0.3 degrees (1/16 inch per foot) or more than 30 degrees below a horizontal line. Leaders shall fit over the outlet tube in gutter bottom and shall fit into and be riveted to the downspout. Strainers shall be set loosely in the eave tube opening in gutter. Joints between lengths of downspouts shall be made by telescoping the end of the upper lengths at least ¾ inch into the lower length. Downspouts terminating at splash blocks or splash pans shall be provided with elbow-type fittings where cast iron boots are not indicated. Downspout hangers shall be provided adjacent to the joint at the top of each section of downspout except that the bottom section shall have an additional strap adjacent to the bottom joint when splash blocks or splash pans are required. Hangers shall be (1/16 inch by one inch) flat stock of the same material as the downspout and secured to wall with appropriate fasteners, three per downspout over six feet long, two per downspout under six feet long.

3.9 GUTTERS: Gutters shall terminate at least ½ inch away from vertical surfaces. Gutter brackets and spacers shall be fastened to roof nailer by screws or deformed shank-type nails and shall interlock with or be fastened to the leading edge of the gutter. Gutter spacers shall be (1/16 inch by one inch) flat stock of the same material as the gutter. Brackets and spacers shall be alternated at not more than 36 inches on center. Gutters shall be hung with high points at ends or equidistant from downspouts and shall have a slope of not less than 0.3 degrees (1/16 inch per foot). Provide for expansion in gutter runs over 40 feet in length.

3.10 CLEANING AND PROTECTION

3.10.1 Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

3.10.2 Provide final protection and maintain conditions that ensure sheet metal flashing and trim work during construction are without damage or deterioration other than natural weathering at the time of acceptance of work.

3.11 CONTRACTOR'S QUALITY CONTROL

The Contractor shall establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

(1) Observe environmental conditions; number and skill level of sheet metal workers; and condition of substrate.

(2) Verify compliance of materials before, during, and after installation.

TABLE 1 - SHEET METAL JOINTS

Item Description	**Aluminum, inch**	**Galvanized Steel, Gauge**	**Copper, Ounce**
Building expansion joint at Roof	0.040"; 1-1/4" single standing seam, cleated	24 gauge; 1-1/4" single standing seam, cleated	N/A
Cleats (Continuous)	0.050"; butt	20 gauge; butt	16 ounce, butt
Flashings:			
Valley	N/A	24 gauge; 6-inch lap, cleated	16 ounce; 6-inch lap, cleated
Gutters*	0.051"; 1" flat locked, riveted, & sealed	24 gauge; 1" flat locked, riveted, & sealed	16 ounce; 1-1/2" lap, riveted & soldered
Reglets **	N/A	26 gauge; 1" lapped, riveted & sealed	16 ounce; butt joint

* Use hard setting sealant for locked aluminum joints

**Seal reglet groove with continuous bead of polyurethane sealant.

*** END OF SECTION ***

PART 1.0 - GENERAL:

1.1 REFERENCES: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. All publications shall be the latest in effect on the date of solicitation. The Contractor shall comply with all Federal, State, and local regulations.

ASTM A526	Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process, Commercial Quality.
ASTM A792	Steel Sheet, Aluminum-Zinc Alloy-Coated by the Hot Dip Process
ASTM D2244	Calculation of Color Differences from Instrumentally Measured Color Coordinates.
ASTM D2822	Asphalt Roof Cement.
NRCA	Roofing and Waterproofing Manual.
SMACNA	Architectural Sheet Metal Manual.

1.2 SUBMITTALS FOR REVIEW: The following shall be submitted in accordance with AF Form 66 and Specification Section 01010 General Requirements, Paragraph 16.0 - Submittal Requirements:

1.2.1 Product Data: Provide data on shape of components, materials and finishes, anchor types, and locations.

1.2.2 Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.

1.2.3 Submit one component sample of each type of manufactured roof specialty.

1.3 QUALITY ASSURANCE: Perform Work in accordance with SMACNA and NRCA criteria.

PART 2.0 PRODUCTS

2.1 COMPONENTS

2.1.1 Copings: Copings shall be; 22 gauge galvanized Kynar 500 pre-finished sheet metal. Color shall match base-wide anodized dark bronze (unless another color from the manufacturer's standard colors is indicated in individual task order's statement of work); size per drawings and/or existing conditions. Include pre-fabricated mitered corners; cleat (or anchor plate) of twenty (20) gauge thick commercial quality galvanized steel. All exposed panel joints shall be vertical, hemmed, & folded edges creating a watertight seal without the use of sealant.

2.1.2 Gravel Stops: Gravel stops shall be equal to Johns-Manville Presto Lock Fascia System; system is composed of 24 gauge galvanized water dam; 22 gauge galvanized Kynar 500 pre-finished sheet metal cover plate and extender plate, and concealed splice plates (cover, extender, and continuous connector) of the same material. Size per drawings and/or existing conditions. Gravel stop system shall include accessories such as inside and outside corners, fascia sumps, and scuppers, as required.

2.1.3 Control Joint / Expansion Joint: Refer to detail drawings 30 & 31; constructed of 22 gauge prefinished sheet metal. Bellows type control/expansion joints are not allowed.

2.1.4 Cover Board 1: Provide 1/2" thick Securock Gypsum-Fiber or Dens Deck Prime (or approved equal) secured to deck with fastener spacing as designed by the manufacturer.

2.1.5 Cover Board 2: SecurShield HD polyiso insulation, 1/2" thick in 4'x8' panels, R value of 2.5, or equal. Secure to deck with fastener spacing as designed by the manufacturer.

2.1.6 Roof Vent (Shingle Roof): Roof vent shall be equal to Lomanco #750 with a net free area of fifty (50) square inches, three sides louvered, all-aluminum construction, weather-tight seamed collar; nailing flange; and bird-proof. Color shall be Weathered Bronze (or another standard color, as indicated in individual task order).

2.1.7 Gutter and Downspout: Gutters and downspouts shall be 24 gauge galvanized Kynar 500 pre-finish, color shall match base-wide anodized dark bronze (unless another color from the manufacturer's standard colors is indicated in individual task order's statement of work); profiles as indicated on the Drawings/SOW.

2.1.8 Aluminum Soffit Ventilating Panel: Soffit ventilating panel shall be equal to PAC-750 Soffit Full Vent in 12" width, 1/2" depth, 0.032 thickness aluminum, with Kynar 500 finish from Peterson Aluminum Corp., 1-800-PAC-CLAD, www.pac-clad.com, or approved equal. Provide solid and/or perforated panels as indicated on the drawings/SOW. Provide matching trim to support panel edges.

2.1.9 Soffit Panel (Solid): Equal to Peterson Aluminum 750 Solid with V groove with Kynar 500 finish. Provide matching perimeter trim, panel splice, "J" closure, and flashing installed per manufacturer's instructions.

2.1.10 Soffit Panel (Vent): Equal to Peterson Aluminum 750 Full Vent with V groove with Kynar 500 finish. Provide matching perimeter trim, panel splice, "J" closure, and flashing installed per manufacturer's instructions.

2.1.11 Roof Drain: Roof drains shall be equal to Johns Manville "USII RetroDrain" comprised of 0.064" spun 1100 aluminum retrofit drain with a cast aluminum strainer dome; readily connects to Schedule 40 or 80 drainage leader. Use with built-up roofing or modified bitumen roof systems. This product shall also be used as overflow drain.

2.1.12 Counter Flashing & Reglets: Shall be equal to Fry Springlok. Use MA for typical installation with sealed reglet. Use SM surface mounted only where approved by CO. See Exposed Fasteners below for use with all SM applications. Provide in galvanized steel; use galvanized steel with Kynar 500 finish if visible from ground. Provide factory welded corners.

2.1.13 Roof Curb: Roof Curbs shall be equal to Custom Curb CRC-2 insulated roof curb with 3"x3" cant and nominal 2"x2" pressure treated wood nailer; height as required.

2.1.14 Flexible Pipe Flashing (Sloped Roofing): Flexible pipe flashing shall be the metal roofing system manufacturer's standard product of a configuration to seal around circular pipe penetrations and prevent intrusion of water through the metal roofing membrane. Flexible pipe flashing shall consist of a flexible ring of EPDM or other suitable material bonded to a malleable steel draw-ring which when fastened to the roofing membrane will weatherproof the penetration. Exposed portions of the flashing system & pipe penetration shall be finished to match the roofing panel in color.

2.1.15 Roof Penetration Seals (Pitch Pans): ("flat roof", Built-up, SBS, Single Ply Roofing): Provide precast form & 100% pourable sealer similar to Chem Curb (www.chemlink.com) at all non-heat roof penetrations.

2.1.16 Downspout Boots: cast iron; size to fit connecting downspout; three (3) feet long; factory coat with rust-inhibited primer. Provide McKinley Model DS4, or equal, boot to connect downspout below grade to horizontal pipe system; and McKinley Model DS8, or equal, boot to install with splash block. McKinley Iron Works, Inc., 800-792-2273, or approved equal.

2.1.17 Fiber Cement Fascia: 3/4" thickness in Rustic Grain finish. James Hardie "HardieTrim" or approved equal with caulked joints & painted. Provide miter cut face joints. Behind gutters, provide

single layer of fascia with a minimum of 1/2" drip offset to soffit. At non-gutter locations, provide 2 step fascia (3/4" thick outer & 3/4" thick inner fascia) minimum of 1/2" drip offset to soffit; outer trim fascia shall extend 1" below drip edge. Set nail heads & caulk prior to painting.

2.1.18 Fiber Cement Soffit (Vented): James Hardie "HardieSoffit" vented Cedarmill or approved equal with caulked joints & painted. Provide 2" wide Hardie soffit material for battens at all seams. Secure with coated exterior screws or hot-dipped galvanized ring shank nails. Refer to manufacturer's instructions for required blocking & fastener spacing. Set nail heads & caulk prior to painting.

2.1.19 Fiber Cement Soffit (Non-Vented): James Hardie "HardieSoffit" non-vented Cedarmill or approved equal with caulked joints & painted. Provide 2" wide Hardie soffit material for battens at all seams. Secure with coated exterior screws or hot-dipped galvanized ring shank nails. Refer to manufacturer's instructions for required blocking & fastener spacing. Set nail heads & caulk prior to painting.

2.1.20 Exposed Fasteners: Fasteners shall be the manufacturer's standard zinc-coated steel, corrosion resistant steel, or nylon capped steel. Exposed fasteners shall be "long life" shielded gasket washers on the exterior side of the covering to waterproof the penetration, ZXL SteelBinder or equal. Washer material shall be compatible with the covering and have a minimum diameter of 3/8 inch. Gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Fasteners used for structural connectors and concealed clips shall be sized and spaced in order to provide a UL wind classification class 90 rating when tested in accordance with UL 580, to ensure structural integrity of the roofing system. Exposed rivets shall be closed-end type where watertight connections are required. **Exposed fasteners shall match the surrounding material in color.**

2.1.21 Plywood Roofing Deck Screws (wood trusses): All roofing plywood shall be secured to wood framing below with PAMFAST flat-head 2/3 coarse-thread screw with minimum 1-1/4" truss penetration, yellow zinc plated, waxed, similar to WCYZ8200 #8 x 2", by PAM Fastening Tech, 1-800-699-2674, www.pamfast.com, or approved equal. Provide maximum screw spacing of 8" o.c. & additional screw within 1" of each plywood corner.

2.1.22 Plywood Roofing Deck Screws (14-20 gauge metal trusses): All roofing plywood shall be secured to metal framing below with PAMFAST SPCZ8112 #8 x 1 1/2" SP, CZ, full fine thread, piercing point, clear zinc, flat head, by PAM Fastening Tech, 1-800-699-2674, www.pamfast.com, or approved equal. Provide maximum screw spacing of 8" o.c. & additional screw within 1" of each plywood corner.

2.1.23 Skylight 1: Provide nominal 3'x3' twin polycarbonate dome meeting OSHA 1910.23(3)(8) 1200 lb impact loading mill finish aluminum skylight; American Skylites, 855-772-7401 or equal. Outer glazing shall be bronze & inner glazing shall be clear. Framing shall be 0.125"x2"x2" extruded aluminum, welded corners, & secured with S.S. fasteners.

2.1.24 Skylight 2: Provide nominal 4'x4' twin polycarbonate dome meeting OSHA 1910.23(3)(8) 1200 lb impact loading mill finish aluminum skylight; American Skylites, 855-772-7401 or equal. Outer glazing shall be bronze & inner glazing shall be clear. Framing shall be 0.125"x2"x2" extruded aluminum, welded corners, & secured with S.S. fasteners.

2.1.25 Skylight 3: Provide S.F. CLIN cost for twin polycarbonate dome meeting OSHA 1910.23(3)(8) 1200 lb impact loading mill finish aluminum skylight; American Skylites, 855-772-7401 or equal. Outer glazing shall be bronze & inner glazing shall be clear. Framing shall be 0.125"x2"x2" extruded aluminum, welded corners, & secured with S.S. fasteners.

2.1.26 Aluminum Curb: Provide fully welded mechanical & skylights curbs from LMcurbs.com, 903-297-2148, insulated & urethane painted exterior finish, or equal. Curbs shall be constructed from 0.125" aluminum with continuously welded seams. Provide curb base sides extending to the next natural seam of the roof panel, allowing the cap strips to seal the seam making the curb an integral part of the roof

system. Existing buildings shall be field measured & curbs ordered specifically for each opening. Provide integral cricket on uphill side of curb.

2.1.27 Remove & Reinstall Existing Antenna: Provide temporary support to keep existing fire alarm & mass notification antennas in operation at all times.

2.1.28 Antenna Support: Provide rigid metallic conduit & anchors to support existing antenna. Paint assembly upon completion.

2.2 FLASHING MATERIALS

2.2.1 Sheet Flashings: ASTM A526; 24 gauge thick steel with minimum 1.25 ounce per square foot galvanized coating only where unseen from ground view. All other exposed flashings to match gutters, fascia, or asphalt shingles and shall be Kynar 500 pre-finished. Coordinate colors & their locations with CO prior to installation.

2.2.2 Bituminous Paint: Acid and alkali resistant type; black color.

2.3 ACCESSORIES

2.3.1 Sealant: Manufacturer's standard type suitable for use with installation of system; non-staining, non-skinning, non-shrinking and non-sagging; ultra-violet and ozone resistant, color as selected.

2.3.2 Roofing Cement: ASTM D2822, Type I, cutback asphalt type.

2.4 FINISHES

2.4.1 Aluminum: Smooth finish.

2.4.2 Galvanized Steel: ASTM A526, commercial quality. Coating designation G90, not chemically treated, not oiled, phosphated.

2.4.3 Galvalume Steel: pre-finished.

2.4.4 Solder, Flux and Accessories: As necessary and compatible with the material being installed.

2.5 FLASHING FABRICATION

2.5.1 Form flashings to profiles indicated on statement of works and/or to protect roofing materials from physical damage and shed water.

2.5.2 Form sections square and accurate to profile, in maximum possible lengths, free from distortion or defects detrimental to appearance or performance.

2.5.3 Hem exposed edges of flashings minimum 1/4 inch on underside.

2.5.4 Apply bituminous paint on concealed surfaces of flashings.

PART 3.0 - EXECUTION

3.1 EXAMINATION

3.1.1 Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

3.1.2 Fascia, Gravel Stop, and Coping: Verify that coverage onto vertical finish materials is sufficient to result in watertight installation. Also verify that membrane terminations and base flashings are in place, sealed, and secure.

3.2 INSTALLATION

3.2.1 General: Install components in accordance with manufacturer's instructions. Conform to SMACNA - Architectural Sheet Metal Manual and NRCA – Roofing and Waterproofing Manual.

3.2.1.1 Coordinate installation of components of this section with installation of roofing system and related flashings. Coordinate installation of flashing flanges as indicated on the drawings and/or in accordance with manufacturer’s recommendations. Securely anchor roof accessories to supporting substrates with appropriate type fasteners.

3.2.1.2 Install units plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction.

3.2.1.3 Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness. Apply bituminous paint on metal surfaces of units in contact with cementitious materials and dissimilar metals.

3.2.2 Expansion Joints: Where installed over asphalt roof membrane and base flashings, set metal flanges in full bed of roofing cement. Splice sections in accordance with SMACNA Plate 68, Alternate One, producing a watertight installation.

3.2.3 Fascia and Coping: Secure in place with concealed fasteners using methods as recommended by manufacturer to comply with FM rating. Seal joints watertight.

3.2.4 Curbs: Integrate curbs with adjacent roofing systems, base flashings, and counter flashings to create watertight conditions.

3.2.5 Collars: Leave exposed area per manufacturer’s recommendations around flue piping where it penetrates roof.

3.2.6 Downspout Boots: Prepare downspout to be received into downspout boot. Provide expansion bolts and shields or other fasteners, as appropriate, for attachment of downspout boots to substrate.

3.2.7 Cleaning: Clean as recommended by manufacturer. Do not use materials or methods which may damage finish or surrounding construction. Clean primer, adhesive, flashing cements, and other products from surfaces, and exposed sheet metal.

3.3 INCIDENTAL ITEMS: Provide all incidental items required for complete, fully functional installation of each roof specialty, including demolition of any existing construction that interfere with the installation of a new roof specialty; fasteners; roofing cement; and solder, flux, and accessories, as required.

*** END OF SECTION ***

PART 1.0 - GENERAL

1.1 REFERENCES

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

ASTM E 84	Surface Burning Characteristics of Building Materials
ASTM E 119	Fire Tests of Building Construction and Materials
ASTM E 814	Fire Tests of Through-Penetration Fire Stops
UL 723	Test for Surface Burning Characteristics of Building Materials
UL 1479	Fire Tests of Through-Penetration Firestops
UL 2079	Tests for Fire Resistance of Building Joint Systems
UL Fire Resistance Directory	(2 Volumes)

1.2 SUBMITTALS: The following shall be submitted in accordance with AF Form 66 and Specification Section 01010 General Requirements, Paragraph 16.0 - Submittal Requirements:

1.2.1 Detail drawings including manufacturer's descriptive data, typical details, installation instructions and the fire-test data and/or report as appropriate for the fire resistance rated construction and location. Submittal shall indicate the fire-stopping material to be provided for each type of application. When more than five (5) penetrations or construction joints are to receive fire-stopping, drawings shall indicate location and type of application.

1.2.2 Certificates attesting that fire-stopping material comply with the specified requirements. The label or listing of the Underwriters Laboratories will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing agency equipped to perform such services, stating that the items have been tested and conform to the specified requirements and testing methods.

1.2.3 Documentation of training and experience.

1.2.4 Manufacturer's representative certification stating that fire-stopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.3 GENERAL REQUIREMENTS

1.3.1 Fire-stopping shall consist of furnishing and installing a material or a combination of materials to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; fire-stopping material shall not interfere with the required movement of the joint.

Gaps requiring fire-stopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof deck.

1.4 STORAGE AND DELIVERY

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

PART 2.0 - PRODUCTS

2.1 FIRESTOPPING MATERIALS

2.1.1 Fire-stopping materials shall consist of commercially manufactured products complying with the following minimum requirements:

2.1.2 Fire-stopping material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved fire-stopping material as listed in UL Fire Resistance Directory or by a nationally recognized testing laboratory.

2.1.3 Fire-stopping material shall be nontoxic to humans at all stages of application.

2.1.4 Fire-stopping will not be required to have a greater fire resistance rating than that of the assembly in which it is being placed.

2.1.5 Fire-stopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479, except that T Ratings are not required for penetrations smaller than or equal to a 4 inch nominal pipe or 16 square inches in overall cross sectional area. Fire resistance ratings shall be the following:

a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = 1 hour, T Rating = 1-1/2 hour.

b. Penetrations of Fire Resistance Rated Floors and Ceiling-Floor Assemblies: F Rating = 1 hour, T Rating = 111/2 hour.

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

PART 3.0 - EXECUTION

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

3.2 INSTALLATION

3.2.1 Fire-stopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Fire-stopping for filling floor voids four (4) inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the fire-stopped area. Fire-stopping shall be installed in accordance with manufacturer's written instructions. Fire-stopping shall be provided in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

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

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

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

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

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

3.3 INSPECTION: Fire-stopped areas shall not be covered or enclosed until inspection is complete and approved. A manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements.

*** END OF SECTION ***

PART 1.0 - GENERAL

1.1 APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. All publications shall be the latest in effect on the date of solicitation. The Contractor shall comply with all Federal, State, and local regulations.

TT-S-00230C (2)	Sealing Compound: Elastomeric Type, Single Component (for caulking, Sealing and Glazing in Buildings and other Structures)
ASTM D217	Cone Penetration of Lubricating Grease
ASTM D578	Glass Fiber Yarns

1.2 GENERAL REQUIREMENTS: Sealants shall be provided in as indicated or specified. The joint design, shape, and spacing shall be as indicated. Mixing shall be in accordance with instructions provided by the manufacturer of the sealant.

1.3 SUBMITTALS: The following shall be submitted in accordance with AF Form 66 and Specification Section 01010 General Requirements, Paragraph 16.0 - Submittal Requirements:

1.3.1 Certificate of Compliance: Certificates shall include laboratory test reports showing that the sealants have been tested within the last twelve (12) months.

1.3.2 Descriptive Data: Manufacturer's descriptive data including backstop material, primer, and sealer shall be submitted for approval. Descriptive data for elastomeric sealants shall include shelf life, curing time, and mixing instructions for two component sealants.

1.3.3 Samples: One cartridge of each sealant, upon request, specified herein shall be submitted for approval. The sample containers shall include the same information on the label as specified herein for containers delivered to the job.

1.4 ENVIRONMENTAL REQUIREMENTS: The ambient temperature shall be within the limits of 40 to 90 degrees F. when the sealant is applied.

1.5 DELIVERY AND STORAGE: Materials shall be delivered to the job in the manufacturer's original unopened containers. The containers shall include the following information on the label: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time when applicable at the standard conditions for laboratory tests. Sealant compound or components outdated as indicated by shelf life shall not be used. Materials shall be carefully handled and stored to prevent inclusion of foreign materials or exposure to temperatures exceeding 90 degrees F. Sealant tape shall be handled and stored in a manner that will not deform the tape.

PART 2.0 PRODUCTS

2.1 MATERIALS shall conform to the respective specifications and other requirements specified. Each container brought to the jobsite with a different sealant formulation shall be marked for the intended use. For each intended use, the color shall be one of the manufacturer's standard colors as selected by the Contracting Officer.

2.1.1 Sealant: Sealant shall be a one-component, elastometric-type compound conforming to FS TT-S-00230, Type II, Class A, exterior usage.

2.1.2 PRIMER for No. 4 sealant shall be as recommended by the sealant manufacturer. Primer shall have been tested for durability with the sealant to be used and on samples of the surfaces to be sealed.

2.1.3 BACKSTOP MATERIAL shall be resilient urethane or polyvinyl-chloride foam, closed-cell polyethylene foam, closed-cell sponge of vinyl or rubber, polychloroprene tubes or beads, polyisobutylene extrusions, oil less dry jute, or rope yarn. Backstop material shall be nonabsorbent, nonstaining, and compatible with the sealant used. Tube or rod stock shall be rolled into the joint cavity. Preformed support strips for ceramic and quarry tile control-joint and expansion-joint work shall be polyisobutylene or polychloroprene rubber.

2.1.4 BOND PREVENTIVE MATERIALS shall be pressure-sensitive adhesive polyethylene tape, aluminum foil, or wax paper. At the option of the Contractor, backstop material with bond breaking characteristics may be installed in lieu of bond-preventive materials specified.

PART 3.0 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 General: The surfaces of joints to be sealed shall be dry. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from all joint surfaces to be sealed. Oil or grease shall be removed with solvent and surfaces shall be wiped with clean cloths.

3.1.2 Concrete and Masonry Surfaces: Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

3.1.3 Steel Surfaces: Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

3.1.4 Aluminum Surfaces: Aluminum surfaces of windows and doorframes in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be nonstaining.

3.2 APPLICATION

3.2.1 Paper Masking Tape: Paper masking tape shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or compound smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

3.2.2 Bond-Preventive Materials: Bond-preventive materials for No. 4 sealant shall be installed on the bottom of the joint cavity and other surfaces indicated to prevent the sealant from adhering to the surfaces covered by the bond-preventive materials. The materials shall be carefully applied to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond-preventive materials.

3.2.3 Backstops: The back or bottom of joints constructed deeper than indicated shall be packed tightly with backstop material to provide a joint of the depth indicated. Where necessary to provide a backdrop for caulking compound, the joint shall be packed tightly with rope yarn.

3.2.4 Primer: Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not receive primer.

3.2.5 Sealant: Compound shall be gun-applied with a nozzle of proper size to fit the width of joint indicated and shall be forced into grooves with sufficient pressure to expel air and fill the groove solidly. Sealant shall be uniformly smooth and free of wrinkles. Joints shall be tooled slightly concave after sealant is installed. When tooling white or light-color sealant, dry or water-wet tool shall be used.

3.3 CLEANING: The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the caulking and sealing application as work progresses.

3.4 INCIDENTAL ITEMS: Provide all incidental items required for complete, fully functional sealant installation, including paper masking tape, bond preventive materials, backstops, and primer.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN WELDING SOCIETY (AWS)

a.	AWS D1.1	Structural Welding Code - Steel

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
b.	ASTM A 924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
c.	ASTM C 578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
d.	ASTM C 591	Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
e.	ASTM C 612	Mineral Fiber Block and Board Thermal Insulation
f.	ASTM D 2863	Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
g.	ASTM E 283	Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

1.1.1.3 BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

a.	BHMA A115	Specifications for Door and Frame Preparation for Hardware (Incl A115.1, A115.2, A115.4, A115.5, A115.6, A115.12, A115.13, A115.14, A115.15, A115.16, A115.17, A115.18)

1.1.1.4 NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

a.	NAAMM HMMA HMM	Hollow Metal Manual

1.1.1.5 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a.	NFPA 105	Installation of Smoke Door Assemblies
b.	NFPA 252	Standard Methods of Fire Tests of Door Assemblies
c.	NFPA 80	Standard for Fire Doors and Other Opening Protectives

1.1.1.6 STEEL DOOR INSTITUTE (SDI/DOOR)

a. SDI/DOOR 111 Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories

b. SDI/DOOR 113 Determining the Steady State Thermal Transmittance of Steel Door and Frame Assemblies

c. SDI/DOOR A250.11 Recommended Erection Instructions for Steel Frames

d. SDI/DOOR A250.3 Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames

e. SDI/DOOR A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings

f. SDI/DOOR A250.6 Hardware on Steel Doors (Reinforcement - Application)

g. SDI/DOOR A250.8 Recommended Specification for Standard Steel Doors and Frames

1.1.1.7 UNDERWRITERS LABORATORIES (UL)

a. UL 10B Fire Tests of Door Assemblies

1.1.1.8 UNIFIED FACILITIES CRITERIA (UFC)

a. UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Doors

b. Frames

c. Accessories

(1) Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

d. Schedule of doors

e. Schedule of frames

f. Submit door and frame locations.

1.2.1.2 SD-03 Product Data

a. Doors

b. Frames

c. Accessories

(1) Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to SDI/DOOR A250.8 requirements.

1.3 SYSTEM DESCRIPTION

1.3.1.1 Where applicable or required y the Statement of Work (SOW), exterior doors, glazing, and supporting structural elements shall comply with Standards 10 and 12 of the UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

2.1.1 SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware. Undercut where indicated. Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 1-3/4 inch thick, unless otherwise indicated.

2.1.1.1 Classification - Level, Performance, Model - Exterior

a. Dyess Standard Doors

(1) Provide painted & polyurethane or polyisocyanurate insulated exterior hollow metal doors, American National Standards Institute/Steel Door Institute, ANSI/SDI 100, Grade III, extra heavy-duty, Model 2 (Seamless), minimum 16 gauge galvanized steel faces. Provide doors fabricated with thermal resistance value (R-value) of not less than 10.0 when tested according to American Society for Testing and Materials, ASTM C 1363.

2.1.1.2 Classification - Level, Performance, Model – Interior

a. Dyess Standard Doors

(1) Provide painted interior hollow metal doors, American National Standards Institute/Steel Door Institute, ANSI/SDI 100, Grade III, extra heavy-duty, Model 2 (Seamless), minimum 16 gauge galvanized steel faces.

2.2 CUSTOM HOLLOW METAL DOORS

2.2.1 Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size(s), design(s), materials, construction, gages, and finish shall be as specified for standard

steel doors and shall comply with the requirement of NAAMM HMMA HMM. Fill all spaces in doors with insulation. Close top and bottom edges with steel channels not lighter than 16 gage. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion. Prepare doors to receive hardware specified in Section 08 71 00 Door Hardware. Undercut doors where indicated. Doors shall be 1-3/4 inch thick, unless otherwise indicated.

2.3 INSULATED STEEL DOOR SYSTEMS

2.3.1 Doors and frames shall receive phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Doors shall have been tested in accordance with SDI/DOOR A250.4 and shall have met the requirements for Level C. Prepare doors to receive specified hardware. Doors shall be 1-3/4 inch thick. Provide insulated steel doors and where shown.

2.4 SOUND RATED STEEL DOORS

2.4.1 Doors shall be of the sound classification scheduled on the Drawings.

2.5 ACCESSORIES

2.5.1 Shelves for Dutch Doors

2.5.1.1 SDI/DOOR 111. Fabricate shelves of steel not lighter than 16 gage, of the size indicated. Brackets shall be stock type fabricated of the same metal used to fabricate shelves.

2.5.2 Louvers

2.5.2.1 Interior Louvers

a. SDI/DOOR 111, Louvers shall be stationary sightproof type. Detachable moldings on room or non security side of door; on security side of door, moldings to be integral part of louver. Form louver frames of 20 gage steel and louver blades of a minimum 24 gage. Sightproof louvers to be inverted "V" blade design with minimum 55 or inverted "Y" blade design with minimum 40 percent net-free opening.]

2.5.2.2 Exterior Louvers

a. Louvers shall be inverted "Y" or “Z" type with minimum of 30 or 35 percent net-free opening respectively. Weld or tenon louver blades to continuous channel frame and weld assembly to door to form watertight assembly. Form louvers of hot-dip galvanized steel of same gage as door facings. Louvers shall have steel-framed insect screens secured to room side and readily removable. Provide aluminum wire cloth, 18 by 18 or 18 by 16 inch mesh. Net-free louver area to be before screening.

2.5.3 Astragals

2.5.3.1 For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 Door Hardware provide overlapping steel astragals with the doors. For interior pairs of fire rated and smoke control doors, provide stainless steel astragals complying with NFPA 80 for fire rated assemblies and NFPA 105 for smoke control assemblies.

2.5.4 Moldings

2.5.4.1 Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Muntins shall interlock at intersections and shall be fitted and welded to stationary moldings.

2.6 STANDARD STEEL FRAMES

2.6.1 Provide painted 16 ga full profile welded hollow metal door. Refer to ANSI / SDI A250.8-3003 (R2008), SDI-100. Provide rated openings & hardware where required by Contractor's code analysis. Provide matching sealant on exterior & caulk on interior. Form frames to sizes and shapes indicated, with FULLY welded corners. Provide steel frames for doors, transoms, sidelights, mullions, cased openings, and interior glazed panels, unless otherwise indicated.

2.6.1.1 Welded Frames

a. Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

b. Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1 and in accordance with the practice specified by the producer of the metal being welded.

2.6.1.2 Knock-Down Frames

a. Not allowed except for special circumstances.

2.6.1.3 Mullions and Transom Bars

a. Mullions and transom bars shall be closed or tubular construction and be a member with heads and jambs butt-welded thereto or knock-down for field assembly. Bottom of door mullions shall have adjustable floor anchors and spreader connections.

2.6.1.4 Stops and Beads

a. Form stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.6.1.5 Terminated Stops

a. Where indicated, terminate interior door frame stops 6 inch above floor. Do not terminate stops of frames for lightproof, soundproof, or lead-lined doors.

2.6.1.6 Cased Openings

a. Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

2.6.1.7 Anchors

a. Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-

coated or painted with rust-inhibitive paint. All exterior openings & anchoring shall meet UFC 4-020-01 blast requirements.

(1) Wall Anchors

(a) Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

1. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;

2. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to wood studs and closed steel studs with screws, and to open steel studs by welding.

3. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111;

(2) Floor Anchors

(a) Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member.

2.7 FIRE AND SMOKE DOORS AND FRAMES

2.7.1 NFPA 80 and NFPA 105 and this specification. The requirements of NFPA 80 and NFPA 105 shall take precedence over details indicated or specified.

2.7.1.1 Door and Frame Labels

a. Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10B. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

2.7.1.2 Oversized Doors

a. For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

2.7.1.3 Astragal on Fire and Smoke Doors

a. On pairs of labeled fire doors, conform to NFPA 80 and UL requirements. On smoke control doors, conform to NFPA 105.

2.8 WEATHERSTRIPPING

2.8.1 As specified in Section 08 71 00 Door Hardware.

2.8.1.1 Integral Gasket

a. Black synthetic rubber gasket with tabs for factory fitting into factory slotted frames, or extruded neoprene foam gasket made to fit into a continuous groove formed in the frame, may

be provided in lieu of head and jamb seals specified in Section 08 71 00 Door Hardware. Insert gasket in groove after frame is finish painted. Air leakage of weatherstripped doors shall not exceed [0.5] [1.25] cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283.

2.9 HARDWARE PREPARATION

2.9.1 Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to BHMA A115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames, with the exception of frames that will have weatherstripping or gasketing, to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.10 FINISHES

2.10.1 Factory-Primed Finish

2.10.1.1 All surfaces of doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in SDI/DOOR A250.8.

2.10.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

2.10.2.1 Fabricate exterior doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A 924 and ASTM A 653. The coating weight shall meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., (A40) ZF120. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8.

2.11 FABRICATION AND WORKMANSHIP

2.11.1 Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. On wraparound frames for masonry partitions, provide a throat opening 1/8 inch larger than the actual masonry thickness. Design other frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

2.11.1.1 Grouted Frames

a. For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of

stop-applied head and jamb seals.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

3.1.1.1 Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Backfill frames in masonry walls with mortar. For frames in exterior walls, ensure that frames are filled with batt or foam insulation.

3.1.2 Doors

3.1.2.1 Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.1.3 Fire and Smoke Doors and Frames

3.1.3.1 Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated smoke doors and frames in accordance with NFPA 80 and NFPA 105.

3.2 PROTECTION

3.2.1 Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

3.3.1 Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

a. ASCE 7 Minimum Design Loads for Buildings and Other Structures

1.1.1.2 AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

a. ASHRAE FUN IP Fundamentals Handbook, I-P Edition

1.1.1.3 ASME INTERNATIONAL (ASME)

a. ASME B29.400 Combination, "H" Type Mill Chains, and Sprockets

1.1.1.4 ASTM INTERNATIONAL (ASTM)

a. ASTM A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

b. ASTM A 27 Standard Specification for Steel Castings, Carbon, for General Application

c. ASTM A 307 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

d. ASTM A 36 Standard Specification for Carbon Structural Steel

e. ASTM A 48 Standard Specification for Gray Iron Castings

f. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

g. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

h. ASTM A 666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

i. ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

j. ASTM A 924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

k. ASTM B 209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

l. ASTM B 221 Standard Specification for Aluminum and Aluminum-Alloy

	Extruded Bars, Rods, Wire, Profiles, and Tubes
m. ASTM D 2000	Standard Classification System for Rubber Products in Automotive Applications
n. ASTM E 330	Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
o. ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
p. ASTM F 568	Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

1.1.1.5 NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

a. NEMA ICS 2	Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
b. NEMA ICS 6	Standard for Industrial Controls and Systems Enclosures
c. NEMA MG 1	Standard for Motors and Generators
d. NEMA ST 1	Standard for Specialty Transformers (Except General Purpose Type)

1.1.1.6 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a. NFPA 70	National Electrical Code
b. NFPA 80	Standard for Fire Doors and Other Opening Protectives

1.1.1.7 UNDERWRITERS LABORATORIES (UL)

a. UL Bld Mat Dir	Building Materials Directory

1.2 DESCRIPTION

1.2.1 Overhead coiling doors to be counterbalanced doors by methods of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members. Doors to be coiling type, with interlocking slats, complete with anchoring and door hardware, guides, hood, and operating mechanisms, and designed for use on openings as indicated.

1.2.2 Fire-rated door assemblies must bear the Underwriters Laboratories, Warnock Hersey, Factory Mutual or other nationally recognized testing laboratory label for the rating listed on the drawings. Provide a permanent label for each door showing the manufacturer's name and address and the model/serial number of the door.

1.2.3 Oversized fire-rated door assemblies must be provided with a listing agency oversize label, or a certificate signed by an official of the manufacturing company certifying that the door and operator have been designed to meet the specified requirements.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Wind Loading

1.3.1.1 Design and fabricate door assembly to withstand the wind loading pressure of at least 20 pounds per square foot with a maximum deflection of 1/120 of the opening width. Provide test data showing compliance with ASTM E 330. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested. Complete assembly must meet or exceed the requirements of ASCE 7.

1.3.2 Fire-Rated Doors, Frames, and Hardware

1.3.2.1 Provide fire-rated doors, frames, and hardware which are tested, rated, and labeled in accordance with Underwriters Laboratories, Factory Mutual or Warnock Hersey. The labels must indicate the rating in hours, per NFPA 80 of duration of exposure to fire, with a letter following the hourly rating to designate the location for which the assembly is designed and the temperature rise on the unexposed face of the door at the end of 30 minutes of fire exposure.

1.3.2.2 Provide and attach metal UL labels to each item of hardware in accordance with requirements specified in the UL Bld Mat Dir.

1.3.3 Oversized Coiling Fire-rated Door Assemblies

1.3.3.1 Where fire-rated doors and frames exceed the size for which testing and labeling services are offered, furnish certificates of inspection from the UL, Factory Mutual or Warnock Hersey. State within certificates that except for size, doors, frames, and hardware are identical in design, materials, and construction to a door that has been tested and rated.

1.3.4 Operational Cycle Life

1.3.4.1 All portions of the door, hardware and operating mechanism that are subject to movement, wear, or stress fatigue must be designed to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

1.4 SUBMITTALS

1.4.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.4.1.1 SD-02 Shop Drawings

a. Provide fabrication drawings that show complete assembly with hardware and framing details for the following items:
   (1) Overhead Coiling Doors
   (2) Counterbalancing Mechanism
   (3) Manual Door Operators
   (4) Electric Door Operators
   (5) Bottom Bar
   (6) Guides
   (7) Mounting Brackets

(8) Overhead Drum
(9) Hood
(10) Painting

(a) Submit Installation Drawings in accordance with paragraph entitled, "Overhead Coiling Door Assemblies," of this section.

1.4.1.2 SD-03 Product Data

a. Submit manufacturer's catalog data for the following items listing all accessories including supports, locks and latches, and weather stripping.
(1) Overhead Coiling Doors
(2) Hardware
(3) Counterbalancing Mechanism
(4) Manual Door Operators
(5) Electric Door Operators
(6) Fire-Rated Door Assembly

1.4.1.3 SD-05 Design Data

a. Submit equipment and performance data for the following items in accordance with the paragraph entitled, "Performance Requirements," of this section.
(1) Overhead Coiling Doors
(2) Hardware
(3) Counterbalancing Mechanism
(4) Manual Door Operators
(5) Electric Door Operators
(6) Fire-Rated Door

1.4.1.4 SD-10 Operation and Maintenance Data

a. Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies , including the following items:
(1) Materials
(2) Devices
(3) Procedures
(4) Manufacture's Brochures
(5) Parts Lists
(6) Cleaning

1.5 OVERHEAD COILING DOOR DETAIL SHOP DRAWINGS

1.5.1 Provide installation drawings for overhead coiling door assemblies which show elevations of each door type, shape and thickness of materials, finishes, details of joints and connections, and details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details. Show locations of replaceable fusible links wiring diagrams for power, signal and controls. Include a schedule showing the location of each door with the drawings.

1.5.2 Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Provide test data that is legible and of good quality.

1.6 WARRANTY, OPERATION AND MAINTENANCE DATA

1.6.1 Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, including the following items:

1.6.1.1 Materials

1.6.1.2 Devices

1.6.1.3 Manual Door Operators

1.6.1.4 Electric Door Operators

1.6.1.5 Hood

1.6.1.6 Counterbalancing Mechanism

1.6.1.7 Painting

1.6.1.8 Procedures

1.6.1.9 Manufacture's Brochures

1.6.1.10 Parts Lists

1.6.2 Contractor must furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship and that they will remain so for not less than two years after completion and acceptance of the project.

1.6.3 Contractor must warrant that upon notification by the Government, he will immediately make good any defects in material, workmanship, and door operation within the same time period covered by the guarantee, at no cost to the Government.

1.7 DELIVERY AND STORAGE

1.7.1 Delivered doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

PART 2 PRODUCTS

2.1 OVERHEAD COILING DOORS

2.1.1 Curtain Materials and Construction, curtain material and insulation shall be one of the following as indicated on the drawings:

2.1.1.1 Provide curtain slats which are fabricated from steel sheets conforming to ASTM A 653, Grade A, with the additional requirement of a minimum yield point of 228 Megapascal. (33,000 psi.) Provide sheets which are galvanized in accordance with ASTM A 924.

2.1.1.2 Provide curtain slats which are fabricated from Stainless steel sheets conforming to ASTM A 666, Type 304, sheet thickness of 0.025 inch and as required to meet requirements.

2.1.1.3 Provide curtain slats which are fabricated from aluminum sheets conforming to ASTM B 209 sheet or ASTM B 221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch and as required to meet requirements.

2.1.1.4 Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Provide slats which are continuous without splices for the width of the door.

2.1.1.5 Provide slats filled with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces on interior surface of slats.

2.1.2 Non-Insulated Curtains

2.1.2.1 Form Curtains from manufacturer's standard shapes of interlocking slats.

2.1.3 Insulated Curtains

2.1.3.1 Form Curtains from manufacturer's standard shapes of interlocking slats. Supply slat system with a minimum R-value of 6 when calculated in accordance with ASHRAE FUN IP. Slats to consist of a urethane or polystyrene core not less than 11/16 inch thick, completely enclosed within metal facings. Exterior face of slats must be the same gauge as specified for curtains. Interior face must be not lighter than 0.0219 inches. The insulated slat assembly is to have a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E 84.

2.1.4 Curtain Bottom Bar

2.1.4.1 Curtain bottom bars must be pairs of angles from the manufacturer's standard steel, stainless and aluminum extrusions not less than 2.0 by 2.0 inches by 0.188 inch. Steel extrusions must conform to ASTM A 36. Stainless steel extrusions conforming to ASTM A 666, Type 304. Aluminum extrusions conforming to ASTM B 221. Galvanize angles and fasteners in accordance with ASTM A 653 and ASTM A 924. Coat welds and abrasions with paint conforming to ASTM A 780.

2.1.5 Vision Panels

2.1.5.1 Provide complete manufacturer's standard vision panels assembly consist of clear acrylic glazing panels or fire-rated glass as required for the type door set in a neoprene channel with a galvanized-steel frame not less than 0.0359-inch uncoated thickness.

2.1.6 Locks

2.1.6.1 Provide end and/or wind locks of cast steel conforming to ASTM A 27, Grade B; galvanized in accordance with ASTM A 653, ASTM A 153 and ASTM A 924 and secured at every other curtain slat.

2.1.7 Weather Stripping

2.1.6.2 Weather-stripping at the door-head and jamb must be 1/8-inch thick sheet of natural or neoprene rubber with air baffles, secured to the insides of hoods with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 5/8-inch wide and 1/8-inch thick.

2.1.6.3 Threshold weather-stripping must be 1/8-inch thick sheet natural or neoprene rubber secured to the bottom bars.

2.1.6.4 Provide weather-stripping of natural or neoprene rubber conforming to ASTM D 2000.

2.1.7 Locking Devices

2.1.7.1 Slide Bolt to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

2.1.8 Safety Interlock

2.1.8.1 Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.1.9 Overhead Drum, material to match door curtain

2.1.9.1 Fabricate drums from nominal 0.028-inch thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653.

2.1.9.2 Fabricate drums from nominal 0.025-inch thick stainless-steel sheet, Type 304, complying with ASTM A 666.

2.1.9.3 Fabricate drums from nominal 0.040-inch thick aluminum sheet complying with ASTM B 209, of alloy and temper recommended by manufacturer and finish for type of use and finish indicated.

2.2 HARDWARE

2.2.1 All hardware must conform to ASTM A 153, ASTM A 307, ASTM F 568, and ASTM A 27.

2.2.1.1 Guides

a. Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for track adjustment.

2.2.1.2 Equipment Supports

a. Fabricate door-operating equipment supports from the manufacturer's standard steel shapes and plates conforming to ASTM A 36, galvanized in accordance with ASTM A 653 and ASTM A 924. Size the shapes and plates in accordance with the industry standards for the size, weight, and type of door installation.

2.3 COUNTERBALANCING MECHANISM

2.3.1 Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.3.1.1 Brackets

a. Provide the manufacturer's standard mounting brackets of either cast iron or cold-rolled steel with one located at each end of the counterbalance barrel conforming to ASTM A 48.

2.3.1.2 Counterbalance Barrels

a. Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A 53, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 inch per foot of span under full load.

2.3.1.3 Spring Balance

a. One or more oil-tempered, heat-treated steel helical torsion springs installed within the barrel capable of producing sufficient torque to assure easy operation of the door curtain. Provide and size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

2.3.1.4 Torsion Rod for Counter Balance

a. Fabricate rod from the manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

2.4 MANUAL DOOR OPERATORS

2.4.1 Manual Push-Up Door Operators

2.4.1.1 Equip door with manufacturer's recommended lifting handles, locks, and latches. Adjust counterbalance mechanisms so that the required lift or pull for operation does not exceed 25 pounds unless another type of door operator is indicated. Design operating mechanisms so that the curtain can be stopped at any point in its upward or downward travel and will remain in that position until pushed to the fully open or closed position.

2.4.2 Manual Chain-Hoist Door Operators

2.4.2.1 Provide door operators which consist of an endless steel hand chain, chain-pocket wheel, guard, and a geared reduction unit of at least a 3 to 1 ratio, required pull for operation must not exceed 35 pounds.

2.4.2.2 Provide chain hoists to have a self-locking mechanism allowing the curtain to be stopped at any point in its upward or downward travel and to remain in that position until moved to the fully open or closed position.

2.4.2.3 Provide hand chains of cadmium-plated alloy steel conforming to ASME B29.400. Yield point of the chain must be at least three times the required hand-chain pull.

2.4.2.4 Provide chain sprocket wheels of cast iron conforming to ASTM A 48.

2.4.3 Manual Crank-Hoist Door Operators

2.4.3.1 Provide door operators which consist of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit with a maximum 25 lbf force to turn crank. Fabricate gearbox to be oil

tight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device having a self-locking mechanism allowing the curtain to be stopped at any point in its upward or downward travel and remain in that position until moved to the fully open or closed position.

2.5 ELECTRIC DOOR OPERATORS

2.5.1 Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70.

2.5.2 Electric door-operator assemblies must be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Assemblies must be complete with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

2.5.3 Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

2.5.4 Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into and out of operation from floor level, and its use will not affect the adjustment of the limit switches. Provide an electrical or mechanical device which will automatically disconnect the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

2.5.4.1 Door-Operator Types, one of the following as indicated on the drawings or as selected:

a. Provide an operator which is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.

b. Provide an operator which is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.

c. Provide an operator which is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

d. Provide a bench mounted operator which is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.

e. Provide a through-wall operator which is mounted on other side of wall from coil side of door.

2.5.4.2 Electric Motors

a. Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and wattage(horsepower) to move the door in either direction from any position and produce a door-travel speed of not less than 8 nor more than 12 inches per second without exceeding the wattage(horsepower) rating.

b. Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements specified.

2.5.4.3 Motor Bearings

a. Bearings must be bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

b. Pre-lubricate and factory seal bearings in motors less than 375 watts (1/2 horsepower).

c. Equip motors coupled to worm-gear reduction units with either ball or roller bearings.

d. Equip bearings in motors 375 watts (1/2 horsepower) or larger with lubrication service fittings. Fit lubrication fittings with color-coded plastic or metal dust caps.

e. In any motor, bearings that are lubricated at the factory for extended duty periods do not need to be lubricated for a given number of operating hours. Display this information on an appropriate tag or label on the motor with instructions for lubrication cycle maintenance.

2.5.4.4 Motor Starters, Controls, and Enclosures

a. Each door motor must have a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 120-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Control equipment must conform to NEMA ICS 2.

b. Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.5.4.5 Control Enclosures

a. Provide control enclosures that conform to NEMA ICS 6 for general purpose NEMA Type 1 or oil-tight and dust-tight NEMA Type 13.

2.5.4.6 2.5.6 Transformer

a. Provide starters with 230/460 to 115 volt control transformers with one secondary fuse when it is required to reduce the voltage on control circuits to 120 volts or less. Provide transformer that conforms to NEMA ST 1.

2.5.4.7 Safety-Edge Device

a. Provide each door with a pneumatic safety device extending the full width of the door and located within a U-section neoprene or rubber astragal mounted on the bottom rail of the bottom door section. Device must immediately stop and reverse the door upon contact with an obstruction in the door opening during downward travel and cause the door to return to full-open position. Safety device is not a substitute for a limit switch.

b. Connect safety device to the control circuit through a retracting safety cord and reel.

2.5.4.8 Remote-Control Stations, one of the following as indicated:

a. Provide interior remote control stations which are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." The "CLOSE" button must be the type requiring a constant pressure to maintain the closing motion of the door. When the door is in motion and the "STOP" button is pressed, the door must stop instantly and remain in the stopped position; from

the stopped position, the door may then be operated in either direction.

b. Provide exterior control stations which are full-guarded, momentary-contact three-button standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosures, key-operated, with the same operating functions as specified herein for interior remote-control stations.

2.5.4.9 Speed-Reduction Units

a. Provide speed-reduction units consisting of hardened-steel worm and bronze worm gear assemblies running in oil or grease and encased in a sealed casing, coupled to the motor through a flexible coupling. Drive shafts must rotate on ball- or roller-bearing assemblies that are integral with the unit.

b. Provide minimum ratings of speed reduction units which are in accordance with AGMA provisions for class of service.

c. Ground worm gears to provide accurate thread form; machine teeth for all other types of gearing. Surface harden all gears.

d. Provide bearings which are the antifriction type equipped with oil seals.

2.5.4.10 Chain Drives

a. Provide roller chains that are power-transmission series steel roller type conforming to ASME B29.400, with a minimum safety factor of 10 times the design load.

b. Roller-chain side bars, rollers, pins, and bushings must be heat-treated or otherwise hardened.

c. Provide chain sprockets that are high-carbon steel with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.5.4.11 Brakes

a. Provide brakes which are 360-degree shoe brakes or shoe and drum brakes, solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

2.5.4.12 Clutches

a. Clutches must be the 4-inch diameter, multiple face, externally adjustable friction type or adjustable centrifugal type.

2.6 FIRE-RATED DOOR ASSEMBLY

2.6.1 Provide fire-rated door assemblies with the dimensions, fire rating, and operating type indicated with electric operators and assemblies that do not interfere with manufacturer's standard interconnecting fusible links.

2.6.1.1 Fire Ratings

a. Provide fire-rated door assemblies complying with NFPA 80 Standard for Fire Doors and Other Opening Protectives and UL Fire Resistance.

2.7 SURFACE FINISHING

2.7.1 Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for

recommendations for applying and designating finishes. Noticeable variations in the same metal component are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast. Doors shall be factory finished unless specified otherwise.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Install overhead coiling door assembly, anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, doors must be free from all distortion.

3.1.2 Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the contract documents and as required by the manufacturer.

3.1.3 Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

3.2 ACCEPTANCE PROVISIONS

3.2.1 After installation, adjust hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

3.2.2 Adjust seals to provide weather-tight fit around entire perimeter.

3.2.3 Engage a factory-authorized service representative to perform startup service and checks according to manufacturer's written instructions.

3.2.4 Test the door opening and closing operation when activated by controls or alarm-connected fire-release system. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset door-closing mechanism after successful test.

3.2.5 Test and make final adjustment of new doors at no additional cost to the Government.

3.2.5.1 Maintenance and Adjustment

a. Not more than 90 calendar days after completion and acceptance of the project, the Contractor must examine, lubricate, test, and re-adjust doors as required for proper operation.

3.2.5.2 Cleaning

a. Clean aluminum or stainless steel doors in accordance with manufacturer's approved instructions.

***** END OF SECTION *****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ASTM INTERNATIONAL (ASTM)

a.	ASTM E 283	Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
b.	ASTM F 883	Padlocks

1.1.1.2 BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

a.	BHMA A156.1	Butts and Hinges
b.	BHMA A156.12	Interconnected Locks & Latches
c.	BHMA A156.13	Mortise Locks & Latches, Series 1000
d.	BHMA A156.15	Closer Holder Release Devices
e.	BHMA A156.16	Auxiliary Hardware
f.	BHMA A156.17	Self Closing Hinges & Pivots
g.	BHMA A156.18	Materials and Finishes
h.	BHMA A156.2	Bored and Preassembled Locks and Latches
i.	BHMA A156.21	Thresholds
j.	BHMA A156.22	Door Gasketing and Edge Seal Systems
k.	BHMA A156.3	Exit Devices
l.	BHMA A156.4	Door Controls - Closers
m.	BHMA A156.5	Auxiliary Locks & Associated Products
n.	BHMA A156.6	Architectural Door Trim
o.	BHMA A156.7	Template Hinge Dimensions
p.	BHMA A156.8	Door Controls - Overhead Stops and Holders

1.1.1.3 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a.	NFPA 101	Life Safety Code
b.	NFPA 80	Standard for Fire Doors and Other Opening Protectives

1.1.1.4 STEEL DOOR INSTITUTE (SDI/DOOR)

a.	SDI/DOOR A250.8	Recommended Specification for Standard Steel Doors and Frames

1.1.1.5 UNDERWRITERS LABORATORIES (UL)

a. UL 14C Swinging Hardware for Standard Tin-Clad Fire Doors Mounted Singly and in Pairs

b. UL Bld Mat Dir Building Materials Directory

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Hardware schedule

1.2.1.2 SD-03 Product Data

a. Hardware items

1.2.1.3 SD-08 Manufacturer's Instructions

a. Installation

1.3 HARDWARE SCHEDULE

1.3.1 Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (If fire rated and listed)	BHMA Finish Designation
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1.4 QUALITY ASSURANCE

1.4.1 Hardware Manufacturers and Modifications

1.4.1.1 Provide, as far as feasible, locks, hinges, pivots, and closers of one lock, hinge, pivot, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule. Deliver permanent keys and removable cores to the Contracting Officer, either directly or by certified mail.

1.5.2 Construction Cores

1.5.2.1 Turn over three sets of construction core keys to the contracting officer at the time of

construction core installation.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

2.1.1 Provide hardware to be applied to metal or to prefinished doors manufactured to template. Promptly furnish template information or templates to door and frame manufacturers. Conform to BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

2.2.1 Provide all hardware necessary to meet the requirements of NFPA 80 for fire doors and NFPA 101 for exit doors, as well as to other requirements indicated, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Conform to UL 14C for swinging hardware for the tin-clad fire doors. Provide the label of Underwriters Laboratories, Inc. for such hardware listed in UL Bld Mat Dir or labeled and listed by another testing laboratory acceptable to the Contracting Officer.

2.3 HARDWARE ITEMS

2.3.1 Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

2.3.1.1 Hinges

a. BHMA A156.1, ball bearing, 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed.

b. At hollow metal exterior doors, provide continuous hinges in dark bronze finish.

2.3.1.2 Pivots

a. BHMA A156.4.

2.3.1.3 Spring Hinges

a. BHMA A156.17.

2.3.1.4 Locks and Latches

a. Mortise Locks and Latches

(1) Best Door Hardware: Provide Best locksets on all doors, Best model 45H Series, 15 lever, S trim, 626 finish with CoreMax cores. Provide hardware & accessories with stainless steel finish. Provide mortise ball bearing hinges, unless noted otherwise. Furnish locks with manufacturers' CoreMax cores and key system. Key blanks shall be standard style stamped "US property – Do Not Duplicate". Furnish 3 key blanks for each unpinned core provided for cutting by government locksmith. Send permanent cores and key blanks,

from lock manufacturer (or supplier) directly to Dyess Air Force Base by registered mail or other approved means to:

7 CES/CEOHS, Attn: Locksmith
726 Third Street, Building 8007
Dyess AFB, TX 79607-1618
Paul.constantine@us.af.mil
325-696-4154

(2) Contractor shall install Contractor supplied temporary construction cores in all locksets as they are installed in the doors. Final Government cores (provided under this project by Contractor & shipped to the Locksmith) will be installed during/after the final inspection by the Government Locksmith. Provide 1 set of the following for every 50 cores installed in each project (1 each minimum per project): EO CSE core service parts, E1, E2, E3, E4, E5,F1, F2, F3, F4, F5, F6, F7, F8, 22S service equipment, and SE pkg 21C caps 500 A40317. Submit registered mail tracking receipt to government on AF 3000 for tracking & documentation.

2.3.1.5 Exit Devices

a. Stanley Apex 2000 series in satin stainless steel finish, or equal.

2.3.1.6 Cores

a. Contractor shall provide cores for new locks, including locks provided under other sections of this specification. Provide cores in accordance with base standards above. Cores will set/pinned & installed by Base Locksmith.

b. Plastic inserts shall be maintained in core throughout construction to prevent lockset damage.

2.3.1.7 Keying System

a. Provide a master keying system or an extension of the existing keying system in accordance with base standards unless otherwise specified.

2.3.1.8 Door Bolts

a. Inactive leafs shall have surface bolts top and bottom similar to Rockwood 580-8.

2.3.1.9 Closers

a. Provide Norton 1600 series closers, or equal, at exterior, vestibule doors, rated openings, toilets, and conference rooms.

2.3.1.10 Overhead Stops

a. BHMA A156.8. Provide at locations that would pose a floor stop tripping hazard, provide concealed slide holder with stop and shock absorber.

2.3.1.11 Door Protection Plates

a. BHMA A156.6.

(1) Sizes of Armor, Mop and Kick Plates

(a) 2 inch less than door width for single doors; one inch less than door width for pairs of

doors. Provide 10 inch kick plates for flush doors and one inch less than height of bottom rail for panel doors. Provide a minimum 36 inch armor plates for flush doors and completely cover lower panels of panel doors, except 16 inch high armor plates on fire doors. Provide 4 inch mop plates.

2.3.1.12 Door Stops and Silencers

a. BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.1.13 Padlocks

a. Equipment Yard, Security Bollard Locks, & PIV (fire protection post indicator valves): Provide Best 21B722LWC (Best 21B series, 7 pin housing, stainless steel, 1-1/2" shackle, with weather cover) for all equipment yard gates, security bollards, & PIV's. .

2.3.1.14 Thresholds

a. Primary Exterior Framing (Main Entrances): ABA compliant clear anodized aluminum standard commercial thresholds set in sealant.

b. Secondary Exterior Framing: Provide exterior gasketing, door bottom, rain drip, and aluminum threshold (Pemko 179AT, Pemko subsill with sealant end dams, or equal) in clear anodized finish. Ease edges and corners of any exposed trim.

2.3.1.15 Weather Stripping Gasketing

a. Provide a set to include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weather stripped doors not to exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283. Provide weather stripping with one of the following:

(1) Extruded Aluminum Retainers

(a) Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear (natural) or bronze anodized aluminum as selected.

(2) Interlocking Type

(a) Zinc or bronze not less than 0.018 inch thick.

(3) Spring Tension Type

(a) Spring bronze or stainless steel not less than 0.008 inch thick.

2.3.1.16 Rain Drips

a. Extruded aluminum, not less than 0.08 inch thick, clear anodized. Set drips in sealant and fasten with stainless steel screws.

(1) Door Rain Drips

(a) Approximately 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.

(2) Overhead Rain Drips

(a) Approximately 1-1/2 inch high by 2-1/2 inch projection, with length equal to overall

width of door frame. Align bottom with door frame rabbet.

2.3.1.17 Special Tools

a. Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

2.4 FASTENERS

2.4.1 Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Provide stainless steel or nonferrous metal fasteners that are exposed to weather. Provide fasteners of type necessary to accomplish a permanent installation.

2.5 FINISHES

2.5.1 BHMA A156.18. Provide hardware in BHMA 626 finish (satin chromium plated) over brass, or BHMA 630 finish (satin stainless steel). Items not available in BHMA 626 or BHMA 630 shall be furnished in a similar plated metal finish as selected by the Contracting Officer. Match exposed parts of concealed closers to lock and door trim. Match hardware finish for aluminum doors.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Install hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1.1 Weather Stripping Installation

a. Handle and install weather stripping to prevent damage. Provide full contact, weather-tight seals. Operate doors without binding.

(1) Stop-Applied Weather Stripping

(a) Fasten in place with color-matched sheet metal screws not more than 9 inch on center after doors and frames have been finish painted.

(2) Interlocking Type Weather Stripping

(a) Provide interlocking, self-adjusting type on heads and jambs and flexible hook type at sills. Nail weather stripping to door one inch on center and to heads and jambs at 4 inch on center

(3) Spring Tension Type Weather Stripping

(a) Provide spring tension type on heads and jambs. Provide bronze nails with bronze, stainless steel nails with stainless steel. Space nails not more than 1-1/2 inch on center.

3.1.1.2 Lightproofing and Soundproofing Installation

a. Install as specified for stop-applied weather stripping.

3.1.1.3 Threshold Installation

a. Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves.

3.2 FIRE DOORS AND EXIT DOORS

3.2.1 Install hardware in accordance with NFPA 80 for fire doors, NFPA 101 for exit doors.

3.3 HARDWARE LOCATIONS

3.3.1 SDI/DOOR A250.8, unless indicated or specified otherwise.

3.3.1.1 Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.

3.3.1.2 Mop Plates: Bottom flush with bottom of door.

3.4 FIELD QUALITY CONTROL

3.4.1 After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

3.5 HARDWARE SETS

3.5.1 Provide hardware for aluminum doors under this section. Deliver Hardware templates and hardware, except field-applied hardware to the aluminum door and frame manufacturer for use in fabricating the doors and frames.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

a.	ANSI Z97.1	Safety Glazing Materials Used in Buildings

1.1.1.2 AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

a.	ASCE 7	Minimum Design Loads for Buildings and Other Structures

1.1.1.3 ASTM INTERNATIONAL (ASTM)

a.	ASTM C 1036	Standard Specification for Flat Glass
b.	ASTM C 1048	Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
c.	ASTM C 1172	Standard Specification for Laminated Architectural Flat Glass
d.	ASTM C 1184	Standard Specification for Structural Silicone Sealants
e.	ASTM C 509	Elastomeric Cellular Preformed Gasket and Sealing Material
f.	ASTM C 669	Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
g.	ASTM C 864	Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
h.	ASTM C 920	Standard Specification for Elastomeric Joint Sealants
i.	ASTM D 2287	Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
j.	ASTM D 395	Standard Test Methods for Rubber Property - Compression Set
k.	ASTM D 4802	Poly(Methyl Methacrylate) Acrylic Plastic Sheet
l.	ASTM D 673	Mar Resistance of Plastics
m.	ASTM E 119	Standard Test Methods for Fire Tests of Building Construction and Materials
n.	ASTM E 1300	Determining Load Resistance of Glass in Buildings
o.	ASTM E 2010	Positive Pressure Fire Tests of Window Assemblies
p.	ASTM E 413	Rating Sound Insulation
q.	ASTM E 773	Accelerated Weathering of Sealed Insulating Glass Units
r.	ASTM E 774	Classification of the Durability of Sealed Insulating Glass Units
s.	ASTM E 90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

1.1.1.4 GLASS ASSOCIATION OF NORTH AMERICA (GANA)

a.	GANA Glazing Manual	Glazing Manual
b.	GANA Sealant Manual	Sealant Manual
c.	GANA Standards Manual	Tempering Division's Engineering Standards Manual

1.1.1.5 INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

a.	IGMA TB-3001	Guidelines for Sloped Glazing
b.	IGMA TM-3000	Glazing Guidelines for Sealed Insulating Glass Units
c.	IGMA TR-1200	Commercial Insulating Glass Dimensional Tolerances

1.1.1.6 NATIONAL FENESTRATION RATING COUNCIL (NFRC)

a.	NFRC 100	Procedure for Determining Fenestration Product U-Factors
b.	NFRC 200	Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

1.1.1.7 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a.	NFPA 252	Standard Methods of Fire Tests of Door Assemblies
b.	NFPA 257	Fire Test for Window and Glass Block Assemblies
c.	NFPA 80	Standard for Fire Doors and Other Opening Protectives

1.1.1.8 U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

a.	Energy Star	Energy Star Energy Efficiency Labeling System

1.1.1.9 U.S. GENERAL SERVICES ADMINISTRATION (GSA)

a.	CID A-A-378	Putty Linseed Oil Type, (for Wood-Sash-Glazing

1.1.1.10 U.S. GREEN BUILDING COUNCIL (USGBC)

a.	LEED	Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.1.1.11 U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

a.	16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.1.1.12 UNDERWRITERS LABORATORIES (UL)

a.	UL 752	Bullet-Resisting Equipment
b.	UL MEAPD	Mechanical Equipment and Associated Products Directory

1.1.1.13 UNIFIED FACILITIES CRITERIA (UFC)

a.	UFC 4-010-01	DoD Minimum Antiterrorism Standards for Buildings

1.2 1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Installation

(1) Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

1.2.1.2 SD-03 Product Data

a. Insulating Glass

(1) Documentation for Energy Star qualifications.

b. Local/Regional Materials; (LEED) (if required in the Scope of Work/Statement of Objectives)

(1) Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

1.2.1.3 SD-04 Samples

a. Insulating Glass

b. Glazing Compound

c. Glazing Tape

d. Sealant

(1) One 6 x 6 inch sample of each of the following: tinted glass, patterned glass, heat-absorbing glass, and insulating glass units.

1.2.1.4 SD-07 Certificates

a. Insulating Glass

b. Glazing Accessories

(1) Certificates from the manufacturer attesting that the units meet the luminous and solar radiant transmission requirements for heat absorbing glass.

1.2.1.5 SD-08 Manufacturer's Instructions

a. Setting and sealing materials

b. Glass setting

(1) Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified. Include cleaning instructions for plastic sheets.

1.2.1.6 SD-11 Closeout Submittals

a. Local/Regional Materials; LEED (if required in the Scope of Work/Statement of Objectives)

(1) LEED (tm) documentation relative to local/regional materials credit in accordance with

LEED Reference Guide. Include in LEED Documentation Notebook.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Where applicable or required by the Statement of Work (SOW), exterior glazing, window framing, connections, and supporting structural elements shall comply with Standards 10 of the UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings.

1.4 SYSTEM DESCRIPTION

1.4.1 Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.6 ENVIRONMENTAL REQUIREMENTS

1.6.1 Do not start glazing work until the outdoor temperature is above 40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.7 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

1.7.1.1 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.8 WARRANTY

1.8.1 Warranty for Insulating Glass Units

1.8.1.1 Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government. For control tower units, the warranty period shall be 10 years; warranty shall be signed by the manufacturer.

1.8.2 Monolithic Reflective Glass

1.8.2.1 Manufacturer shall warrant the monolithic reflective glass to be free of peeling or deteriorating of coating for a period of 10 years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

1.8.3 Monolithic Opacified Spandrel

1.8.3.1 Manufacturer shall warrant the opacifier film on the spandrel to be free of peeling for a period of five years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

PART 2 PRODUCTS

2.1 GLASS

2.1.1 ASTM C 1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

2.1.1.1 Clear Glass

a. For interior glazing (i.e., pass and observation windows), 1/4 inch thick glass should be used.

b. Type I, Class 1 (clear), Quality q4 (A). Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 1/8 inch float glass for openings up to and including 15 square feet, 3/16 inch for glazing openings over 15 square feet but not over 30 square feet, and 1/4 inch for glazing openings over 30 square feet but not over 45 square feet.

2.1.1.2 Annealed Glass

a. Annealed glass shall be Type I transparent flat type, Class 1 - clear or tinted, Quality q3 - glazing select, light transmittance, and shading coefficient as indicated or as required by the C.O., conforming to ASTM C 1036. Color shall be as indicated on the drawings or as selected.

2.1.1.3 Heat-Absorbing Glass

a. Type I, Class 2 (heat absorbing and light reducing), Quality q3 (select), thickness, color, light transmittance, and shading coefficient, as indicated or as required by the C.O., conforming to ASTM C 1036. 1/4 inch thickness.

2.1.1.4 Wired Glass

a. Glass for fire-rated windows shall be UL listed and shall be rated as indicated when tested in accordance with ASTM E 2010. Wired glass shall be Type II flat type, Quality q8 - glazing, Form 1 - wired and polished both sides, with light transmittance, and shading coefficient, as indicated or as required by the C.O., conforming to ASTM C 1036. Wire mesh shall be polished stainless steel Mesh 1 - diamond. Wired glass for fire-rated windows shall bear an identifying UL label or the label of a nationally recognized testing agency, and shall be tested in accordance with NFPA 257. Wired glass for fire-rated doors shall be tested as part of a door assembly in accordance with NFPA 252.

2.1.1.5 Patterned Glass

a. Type II, Class 1 (translucent), Form 3 (patterned), Quality q7 (decorative), Finish f1 (patterned

one side) or f2 (patterned two sides). Pattern, light transmittance, and shading coefficient as indicated or as required by the C.O. Thickness as indicated.

2.1.1.6 Laminated Glass

a. ASTM C 1172, Kind LA fabricated from two nominal 1/8 inch pieces of Type I, Class 1, Quality q3, flat annealed transparent glass conforming to ASTM C 1036. Flat glass shall be laminated together with a minimum of 0.030 inch thick, clear polyvinyl butyral interlayer or alternatives such as resin laminates, conforming to requirements of 16 CFR 1201 and ASTM C 1172. The total thickness shall be nominally 1/4 inch. Color shall be as indicated.

2.1.1.7 Bullet-Resisting Glass

a. Fabricated from Type I, Class 1, Quality q3 glass with polyvinyl butyral plastic interlayers between the layers of glass and listed by UL MEAPD as bullet resisting, with a power rating as indicated and in accordance with UL 752.

2.1.1.8 Mirrors

a. Glass Mirrors

(1) Glass for mirrors shall be Type I transparent flat type, Class 1-clear, Glazing Quality q1, 1/4 inch thick conforming to ASTM C 1036. Glass color shall be as indicated. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint, and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.1.1.9 Tempered Glass

a. ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (transparent) or 2 (tinted heat absorbing), Quality q3. Thickness, light transmittance, and shading coefficient as indicated or as required by the C.O., conforming to ASTM C 1048 and GANA Standards Manual. Color shall be as indicated. Provide wherever safety glazing material is indicated or specified.

2.1.1.10 Heat-Strengthened Glass

a. ASTM C 1048, Kind HS (heat strengthened), Condition A (uncoated), Type I, Class 1 (clear) or 2 (tinted heat absorbing), Quality q3.

2.1.1.11 Spandrel Glass

a. Ceramic-Opacified Spandrel Glass

(1) Ceramic-opacified spandrel glass shall be Kind HS heat-strengthened transparent flat type, Condition B, coated with a colored ceramic material on No. 2 surface, Quality q3 - glazing select, inch thick, conforming to ASTM C 1048. Color shall be as indicated.

b. Film-Opacified Spandrel Glass

(1) Film-opacified spandrel glass shall be Kind HS heat-strengthened transparent flat type, Quality q3 - glazing select, Condition C glass with a polyester or polyethylene film 2 mils to 5 mils thick attached to No. 2 surface of a sputtered solar-reflective film, conforming to ASTM C 1048. Film opacification shall be compatible to and specifically developed for application to solar reflective films. Color shall be as specified.

c. Spandrel Glass With Adhered Backing

(1) ASTM C 1048, Kind HS or FT, Condition B (ceramic coated), Type I, Quality q5, inch thick and shall pass the fallout resistance test specified in ASTM C 1048.

2.1.1.12 Fire/Safety Rated Glass

a. Fire/safety rated glass shall be laminated Type I transparent flat type, Class 1-clear. Glass shall have the indicated rating when tested in accordance with ASTM E 119. Glass shall be permanently labeled with appropriate markings.

2.1.1.13 Tinted (Light-Reducing) Glass

a. Tinted (light-reducing) glass shall be Type I transparent flat type, Class 3-tinted, Quality q3 - glazing select, .50 percent light transmittance, .35 percent shading coefficient, as indicated or as required by the C.O., conforming to ASTM C 1036. Color shall be as indicated.

2.2 INSULATING GLASS UNITS

2.2.1 Two panes of glass separated by a dehydrated, 1/2 inch airspace, and hermetically sealed. Glazed systems (including frames) shall be Energy Star labeled products as appropriate to climate zone and as applicable to window type, with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of .40 determined according to NFRC 200 procedures. Glazed panels and curtain walls shall have a U-factor maximum of .35 Btu per square foot x hr x degree F in accordance with NFRC 100. Glazing shall meet or exceed a luminous efficacy of 1.0. Glazed panels shall be rated for not less than 30 Sound Transmission Class (STC) when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413. Dimensional tolerances shall be as specified in IGMA TR-1200. The units shall meet CBA Grade requirement when tested in accordance with ASTM E 773 and ASTM E 774, Class A. Spacer shall be black, roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

2.2.1.1 Buildings

a. The inner light shall be ASTM C 1172, clear annealed flat glass Type I, Class I, Quality q3, ASTM C 1036, Type I, Class 1, Quality q4, or ASTM C 1048, Grade B (fully tempered), as indicated or as required by the C.O., Style I (uncoated), Type I, Class 1 (transparent), Quality q4, thickness as indicated. The outer light shall be ASTM C 1036, Type I, Class 1 (transparent), 2 (tinted heat absorbing), 2 (solar-reflective), Quality q4, ASTM C 1048, Grade B (fully tempered), Style I (uncoated), Type I, Class 1 (clear) or 2 (tinted heat absorbing), Quality q4, thickness as indicated.

2.2.1.2 Low Emissivity Insulating Glass

a. Interior and exterior glass panes for Low-E insulating units shall be Type I annealed flat glass, Class 1-clear or 2-tinted with anti-reflective low-emissivity coating on No. 2 surface (inside

surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be U-Value/Winter Nighttime .35, shading coefficient .40. Color shall be as indicated on the drawings or as selected.

2.3 SETTING AND SEALING MATERIALS

2.3.1 Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

2.3.1.1 Putty and Glazing Compound

a. Glazing compound shall conform to ASTM C 669 for face-glazing metal sash. Putty shall be linseed oil type conforming to CID A-A-378for face-glazing primed wood sash. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

2.3.1.2 Glazing Compound

a. ASTM C 669. Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

2.3.1.3 Sealants

a. Provide elastomeric and structural sealants.

(1) Elastomeric Sealant

(a) ASTM C 920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing wood and metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes, and with plastic sheet. Color of sealant shall be white.

(2) Structural Sealant

(a) ASTM C 1184, Type S.

2.3.1.4 Joint Backer

a. Joint backer shall have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.3.1.5 Preformed Channels

a. Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition. Channels for bullet-resistant glass shall be synthetic rubber, ASTM C 864, not less than 1/4 inch thick and sufficiently resilient to accommodate expansion and contraction while maintaining a vaportight seal between glass and frame. Channels shall be chemically compatible with plastic sheet.

2.3.1.6 Sealing Tapes

a. Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D 2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

2.3.1.7 Setting Blocks and Edge Blocks

a. Closed-cell neoprene setting blocks shall be dense extruded type conforming to ASTM C 509 and ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer. Block color shall be black.

2.3.1.8 Glazing Gaskets

a. Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

(1) Fixed Glazing Gaskets

(a) Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1.

(2) Wedge Glazing Gaskets

(a) Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75.

(3) Aluminum Framing Glazing Gaskets

(a) Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.3.1.9 Accessories

a. Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

2.4 MIRROR ACCESSORIES

2.4.1 Mastic

2.4.1.1 Mastic for setting mirrors shall be a polymer type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Mastic shall be compatible with mirror backing paint, and shall be approved by mirror manufacturer.

2.4.2 Mirror Frames

2.4.2.1 Mirrors shall be provided with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames shall be 1-1/4 x 1/4 x 1/4 inch continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.

2.4.3 Mirror Clips

2.4.3.1 Concealed fasteners of type to suit wall construction material shall be provided with clips.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

3.2.1 Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1.1 Sheet Glass

a. Cut and set with the visible lines or waves horizontal.

3.2.1.2 Patterned Glass

a. Set glass with one patterned surface with smooth surface on the weather side. When used for interior partitions, place the patterned surface in same direction in all openings.

3.2.1.3 Insulating Glass Units

a. Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation shall conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

3.2.1.4 Installation of Wire Glass

a. Install glass for fire doors in accordance with installation requirements of NFPA 80.

3.2.1.5 Installation of Heat-Absorbing Glass

a. Glass shall have clean-cut, factory-fabricated edges. Field cutting will not be permitted.

3.2.1.6 Installation of Laminated Glass

a. Sashes which are to receive laminated glass shall be weeped to the outside to allow water drainage into the channel.

3.3 CLEANING

3.3.1 Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the work is accepted. Clean plastic sheet in accordance with manufacturer's instructions.

3.4 PROTECTION

3.4.1 Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

3.5 WASTE MANAGEMENT

3.5.1 Disposal and recycling of waste materials, including corrugated cardboard recycling, shall be in accordance with the Waste Management Plan. Upon removal, separate protective materials and reuse or recycle. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.

*** END OF SECTION ***

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

a. ANSI A108.11 Interior Installation of Cementitious Backer Units

b. ANSI/CTI A108/A118/A136.1 Specification for the Installation of Ceramic Tile

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a. ASTM C 1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

b. ASTM C 1047 Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base

c. ASTM C 1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing

d. ASTM C 1178 Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel

e. ASTM C 1396 Standard Specification for Gypsum Board

f. ASTM C 36 Gypsum Wallboard

g. ASTM C 442 Gypsum Backing Board, Gypsum Coreboard, and Gypsum Shaftliner Board

h. ASTM C 475 Joint Compound and Joint Tape for Finishing Gypsum Board

i. ASTM C 514 Standard Specification for Nails for the Application of Gypsum Board

j. ASTM C 630 Water-Resistant Gypsum Backing Board

k. ASTM C 79 Treated Core and Nontreated Core Gypsum Sheathing Board

l. ASTM C 840 Application and Finishing of Gypsum Board

m. ASTM C 954 Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. to 0.112 in. in Thickness

n. ASTM D 1037 Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

o. ASTM D 1149 Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber

p. ASTM D 226 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

q. ASTM D 2394 — Simulated Service Testing of Wood and Wood-Base Finish Flooring

r. ASTM D 412 — Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

s. ASTM D 5420 — Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact)

t. ASTM D 624 — Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

u. ASTM E 695 — Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading

v. ASTM E 84 — Standard Test Method for Surface Burning Characteristics of Building Materials

1.1.1.3 GYPSUM ASSOCIATION (GA)

a. GA 214 — Recommended Levels of Gypsum Board Finish

b. GA 216 — Application and Finishing of Gypsum Board

c. GA 224 — Installation of Predecorated Gypsum Board

d. GA 253 — Application of Gypsum Sheathing

e. GA 600 — Fire Resistance Design Manual

1.1.1.4 U.S. GREEN BUILDING COUNCIL (USGBC)

a. LEED — Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.1.1.5 UNDERWRITERS LABORATORIES (UL)

a. UL Fire Resistance — Fire Resistance Directory

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-03 Product Data

a. Cementitious backer units

b. Glass Mat Water-Resistant Gypsum Tile Backing Board

c. Water-Resistant Gypsum Backing Board

d. Glass Mat Covered or Reinforced Gypsum Sheathing

e. Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

f. Impact Resistant Gypsum Board

g. Accessories

h. Submit for each type of gypsum board and for cementitious backer units.

i. Gypsum Board; (LEED)

(1) Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

(2) Adhesives; (LEED)

j. Joint Treatment Materials

(1) Submit manufacturer's product data, indicating VOC content.

1.2.1.2 SD-04 Samples

a. Predecorated gypsum board

(1) Submit for each color and pattern of predecorated gypsum board. Where colors are not indicated, submit color selection samples of not less than eight of the manufacturer's standard colors.

1.2.1.3 SD-07 Certificates

a. Asbestos Free Materials

(1) Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

1.2.1.4 SD-08 Manufacturer's Instructions

a. Material Safety Data Sheets

1.2.1.5 SD-10 Operation and Maintenance Data

a. Manufacturer maintenance instructions

b. Waste Management

1.2.1.6 SD-11 Closeout Submittals

a. Local/Regional Materials; (LEED)

(1) LEED documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

b. Gypsum Board; (LEED)

(1) LEED documentation relative to recycled content credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

c. Adhesives; (LEED)

(1) LEED documentation relative to low emitting materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

1.3.1.1 Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

1.3.2 Storage

1.3.2.1 Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Store per manufacturer's recommendations for allowable temperature and humidity range. Gypsum wallboard shall not be stored with materials which have high emissions of volatile organic compounds (VOCs) or other contaminants. Do not store panels near materials that may off gas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.3.3 Handling

1.3.3.1 Neatly stack gypsum board and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

1.4 ENVIRONMENTAL CONDITIONS

1.4.1 Temperature

1.4.1.1 Maintain a uniform temperature of not less than 50 degrees F in the structure for at least 48 hours prior to, during, and following the application of gypsum board, cementitious backer units, and joint treatment materials, or the bonding of adhesives.

1.4.2 Exposure to Weather

1.4.2.1 Protect gypsum board and cementitious backer unit products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

1.4.3 Temporary Ventilation

1.4.3.1 Provide temporary ventilation for work of this section.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

1.5.1 Local/Regional Materials

1.5.1.1 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.6 QUALIFICATIONS

1.6.1 Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

1.7 SCHEDULING

1.7.1 The gypsum wall board shall be taped, spackled and primed before the installation of the highly-emitting materials.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only. Submit Material Safety Data Sheets and manufacturer maintenance instructions for gypsum materials including adhesives.

2.1.1.1 Gypsum Board

a. ASTM C 36 and ASTM C 1396. Gypsum board shall contain a minimum of 5 percent post-consumer recycled content, or a minimum of 20 percent post-industrial recycled content. Paper facings shall contain 100 percent post-consumer recycled paper content. Gypsum cores shall contain a minimum of 95 percent post-industrial recycled gypsum content.

(1) Regular

(a) 48 inch wide, 5/8 inch thick, tapered edges.

(2) Foil-Backed

(a) 48 inch wide, 5/8 inch thick, tapered edges.

(3) Type X (Special Fire-Resistant)

(a) 48 inch wide, 5/8 inch thick, tapered edges.

2.1.1.2 Gypsum Backing Board

a. ASTM C 442, gypsum backing board shall be used as a base in a multilayer system.

(1) Regular

(a) 48 inch wide, 1/2 or 5/8 inch thick, square edges.

(2) Foil-Backed

(a) 48 inch wide, 1/2 or 5/8 inch thick, square edges.

(3) Type X (Special Fire-Resistant)

(a) 48 inch wide, 1/2 or 5/8 inch thick, square edges.

2.1.1.3 Regular Water-Resistant Gypsum Backing Board

a. ASTM C 630

(1) Regular

(a) 48 inch wide, 5/8 inch thick, tapered edges.

(2) Type X (Special Fire-Resistant)

(a) 48 inch wide, 5/8 inch thick, tapered edges.

2.1.1.4 Glass Mat Water-Resistant Gypsum Tile Backing Board

a. ASTM C 1178

(1) Regular

(a) 48 inch wide, 1/2 or 5/8 inch thick, square edges.

(2) Type X (Special Fire-Resistant)

(a) 48 inch wide, 1/2 or 5/8 inch thick, square edges.

2.1.1.5 Glass Mat Covered or Reinforced Gypsum Sheathing

a. Exceeds physical properties of ASTM C 79 and ASTM C 1177. Provide 5/8 inch, gypsum sheathing. Provide gypsum board of with a noncombustible water-resistant core, with glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Warrant gypsum sheathing board for at least six months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing. Seal all joints, seams, and penetrations with compatible sealant.

(1) Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

(a) Provide sealant compatible with gypsum sheathing, rubber washers for masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Provide sealants for gypsum sheathing board edge seams and veneer anchor penetrations recommended by the gypsum sheathing manufacturer and have the following performance requirements:

1. ASTM D 412: Tensile Strength - 80 psi
2. ASTM D 412: Ultimate Tensile Strength (maximum elongation) - 170 psi
3. ASTM D 624: Tear Strength, dieB, - 27 ppi
4. ASTM D 1149: Joint Movement Capability after 14 Days cure - plus or minus 50 percent.

2.1.1.6 Impact Resistant Gypsum Board

a. 48 inch wide, 5/8 inch thick, tapered edges.

(1) Reinforced gypsum panel with imbedded fiber mesh or lexan backing testing in accordance with the following tests. Provide fasteners that meet manufacturer requirements and specifications stated within this section. Impact resistant gypsum board, when tested in accordance with ASTM E 84, have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

(a) Structural Failure Test

1. ASTM E 695 or ASTM D 2394 for structural failure (drop penetration). ASTM E 695 using a 60 lb sand filled leather bag, resisting no less than 300 ft. lb. cumulative impact energy before failure or ASTM D 2394 using 5.5 inch hemispherical projectile resisting no less than 264 ft. lb. before failure. Provide test specimen stud spacing a minimum 16 inch on center.

(b) Indentation Test

1. ASTM D 5420 or ASTM D 1037 for indentation resistance. ASTM D 5420 using a 32 oz weight with a 5/8 inch hemispherical impacting head dropped once 3 feet creating not more than 0.137 inch indentation or ASTM D 1037 using no less than 470 lb weight applied to the 0.438 inch diameter ball to create not more than a 0.0197 inch indentation depth.

2.1.1.7 Cementitious Backer Units

a. ANSI/CTI A108/A118/A136.1.

2.1.1.8 Joint Treatment Materials

a. ASTM C 475. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds shall be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

(1) Embedding Compound

(a) Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

(2) Finishing or Topping Compound

(a) Specifically formulated and manufactured for use as a finishing compound.

(3) All-Purpose Compound

(a) Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

(4) Setting or Hardening Type Compound

(a) Specifically formulated and manufactured for use with fiber glass mesh tape.

(5) Joint Tape

(a) Use cross-laminated or tapered edge tape recommended by the manufacturer. Paper and fiberglass joint tape are not permitted.

2.1.1.9 Fasteners

a. Nails

(1) ASTM C 514.

b. Screws

(1) ASTM C 1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.033 inch thick. ASTM C 954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

c. Staples

(1) No. 16 USS gage flattened galvanized wire staples with 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

(a) Length of Legs (inch) Thickness of Gypsum Board (inch)

1-1/8	1/2
1-1/4	5/8

2.1.1.10 Adhesives

a. Do not use adhesive containing benzene, carbon tetrachloride, or trichloroethylene. Adhesive shall contain a maximum VOC content of 50 grams per liter.

(1) Adhesive for Fastening Gypsum Board to Metal Framing

(a) Not permitted.

(2) Adhesive for Fastening Gypsum Board to Wood Framing

(a) Not permitted.

(3) Adhesive for Laminating

(a) Adhesive attachment is not permitted for multi-layer gypsum boards. For laminating gypsum studs to face panels, provide adhesive recommended by gypsum board manufacturer.

2.1.1.11 Gypsum Studs

a. Provide one inch minimum thickness and 6 inch minimum width. Studs may be of one inch thick gypsum board or multilayers fastened to required thickness. Conform to ASTM C 36 or ASTM C 442 for material.

2.1.1.12 Shaftwall Liner Panel

a. ASTM C 442. Conform to the UL Fire Resistance for the Design Numbers(s) indicated for shaftwall liner panels. Manufacture liner panel for cavity shaftwall system, with water-resistant paper faces, bevel edges, single lengths to fit required conditions, 1" thick, by 24" wide.

2.1.1.13 Accessories

a. ASTM C 1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges shall be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials. For predecorated gypsum board provide prefinished metal or plastic trim to match predecorated gypsum board.

2.1.1.14 Asphalt Impregnated Building Felt

a. Provide a 15 lb asphalt moisture barrier over gypsum sheathing. Conforming to ASTM D 226 Type 1 (No. 15) for asphalt impregnated building felt.

2.1.1.15 Water

a. Provide clean, fresh, and potable water.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

3.1.1.1 Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and cementitious backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and cementitious backer units.

3.1.2 Gypsum Board and Framing

3.1.2.1 Verify that surfaces of gypsum board and framing to be bonded with an adhesive are free of dust, dirt, grease, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.1.3 Masonry and Concrete Walls

3.1.3.1 Verify that surfaces of masonry and concrete walls to receive gypsum board applied with adhesive are dry, free of dust, oil, form release agents, protrusions and voids, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.2 APPLICATION OF GYPSUM BOARD

3.2.1 Apply gypsum board to framing and furring members in accordance with ASTM C 840 or GA 216 and the requirements specified. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may be bonded together with an adhesive, except where prohibited by fire rating(s). Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Minimize framing by floating corners with single studs and drywall clips. Install 5/8 inch gypsum ceiling board over framing at 24 inches on center. Provide type of gypsum board for use in each system specified herein as indicated.

3.2.1.1 Application of Single-Ply Gypsum Board to Wood Framing

a. Apply in accordance with ASTM C 840, System I or GA 216.

3.2.1.2 Application of Two-Ply Gypsum Board to Wood Framing

a. Apply in accordance with ASTM C 840, System II or GA 216.

3.2.1.3 Adhesive Nail-On Application to Wood Framing

a. Apply in accordance with ASTM C 840, System III or GA 216. This method may be used in lieu of ASTM C 840, System I at the option of the Contractor.

3.2.1.4 Semi-Solid Gypsum Board Partitions

a. Provide in accordance with ASTM C 840, System IV or GA 216.

3.2.1.5 Solid Gypsum Board Partitions

a. Provide in accordance with ASTM C 840, System V or GA 216.

3.2.1.6 Adhesive Application to Interior Masonry or Concrete Walls

a. Apply in accordance with ASTM C 840, System VI or GA 216.

3.2.1.7 Application of Gypsum Board to Steel Framing and Furring

a. Apply in accordance with ASTM C 840, System VIII or GA 216.

3.2.1.8 Arches and Bending Radii

a. Apply gypsum board in accordance with ASTM C 840, System IX or GA 216.

3.2.1.9 Gypsum Board for Wall Tile or Tile Base Applied with Adhesive

a. In dry areas (areas other than tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply glass mat water-resistant gypsum tile backing board or water-resistant gypsum backing board in accordance with ASTM C 840, System X or GA 216.

3.2.1.10 Exterior Application

a. Apply exterior gypsum board (such as at soffits) in accordance with ASTM C 840, System XI or GA 216.

3.2.1.11 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

a. Apply gypsum sheathing in accordance to gypsum association publications GA 253. Follow gypsum sheathing manufacturer's requirements of design details for joints and fasteners and be properly installed to protect the substrate from moisture intrusion. Do not leave exposed surfaces of the gypsum sheathing beyond the manufacturer's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in single fashion with edges and ends lapped a minimum of 6 inch. Property flash the openings.

3.2.1.12 Floating Interior Angles

a. Minimize framing by floating corners with single studs and drywall clips. Locate the attachment fasteners adjacent to ceiling and wall intersections in accordance with ASTM C 840, System XII or GA 216, for single-ply and two-ply applications of gypsum board to wood framing.

3.2.1.13 Control Joints

a. Install expansion and contraction joints in ceilings and walls in accordance with ASTM C 840, System XIII or GA 216. Fill control joints between studs in fire-rated construction with firesafing insulation to match the fire-rating of construction.

3.2.1.14 Application of Foil-Backed Gypsum Board

a. Apply foil-backed gypsum board in accordance with ASTM C 840, System XIV or GA 216.

3.2.1.15 Application of Impact Resistant Gypsum Board

a. Apply in accordance with applicable system of ASTM C 840 as specified or GA 216. Follow manufacturers written instructions on how to cut, drill and attach board.

3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS

3.3.1 Application

3.3.1.1 In wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply cementitious backer units in accordance with ANSI A108.11. Place a 15 lb asphalt impregnated, continuous felt paper membrane behind cementitious backer units, between backer units and studs or base layer of gypsum board. Place membrane with a minimum 6 inch overlap of sheets laid shingle style.

3.3.2 Joint Treatment

3.3.2.1 ANSI A108.11.

3.4 FINISHING OF GYPSUM BOARD

3.4.1 Tape and finish gypsum board in accordance with ASTM C 840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish water resistant gypsum backing board, ASTM C 630, to receive ceramic tile to Level 2 in accordance with GA 214. . Finish walls receiving a textured finish to Level 4 in accordance with GA 214. Finish all other gypsum board walls, partitions and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building occupants, and HVAC systems from gypsum dust.

3.4.1.1 Uniform Surface

a. Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

3.5 SEALING

3.5.1 Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 Joint Sealants. Apply material with exposed surface flush with gypsum board or cementitious backer units.

3.5.1.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing

a. Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat.

3.6 FIRE-RESISTANT ASSEMBLIES

3.6.1 Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the

specifications contained in UL Fire Resistance for the Design Number(s) indicated, or GA 600 for the File Number(s) indicated. Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements. Seal penetrations through rated partitions and ceilings tight in accordance with tested systems.

3.7 PATCHING

3.7.1 Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.

3.8 SHAFTWALL FRAMING

3.8.1 Install the shaftwall system in accordance with the system manufacturer's published instructions. Coordinate bucks, anchors, blocking and other items placed in or behind shaftwall framing with electrical and mechanical work. Patch or replace fireproofing materials which are damaged or removed during shaftwall construction.

3.9 WASTE MANAGEMENT

3.9.1 As specified in Waste Management Plan and as follows. Separate clean waste gypsum products from contaminants. Do not include wood, plastic, metal, asphalt-impregnated gypsum board, or any gypsum board coated with glass fiber, vinyl, decorative paper, or other finish. Place in designated area and protect from moisture and contamination.

3.9.2 Identify manufacturer's policy for collection or return of remaining construction scrap, unused material, demolition scrap, and packaging material. Institute demolition and construction recycling to take advantage of manufacturer's programs. When such a service is not available, seek local recyclers to reclaim the materials.

***** END OF SECTION *****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

a. ANSI A137.1 Ceramic Tile

b. ANSI/CTI A108/A118/A136.1 Specification for the Installation of Ceramic Tile

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a. ASTM A 185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

b. ASTM C 1026 Standard Test Method for Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling

c. ASTM C 1027 Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile

d. ASTM C 1028 Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

e. ASTM C 1178 Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel

f. ASTM C 144 Standard Specification for Aggregate for Masonry Mortar

g. ASTM C 150 Standard Specification for Portland Cement

h. ASTM C 206 Standard Specification for Finishing Hydrated Lime

i. ASTM C 207 Standard Specification for Hydrated Lime for Masonry Purposes

j. ASTM C 241 Standard Specification for Abrasion Resistance of Stone Subjected to Foot Traffic

k. ASTM C 33 Standard Specification for Concrete Aggregates

l. ASTM C 373 Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products

m. ASTM C 482 Bond Strength of Ceramic Tile to Portland Cement

n. ASTM C 501 Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser

o. ASTM C 648 Breaking Strength of Ceramic Tile

p. ASTM C 847 Standard Specification for Metal Lath

q. ASTM D 2103 Standard Specification for Polyethylene Film and Sheeting

r. ASTM D 226 Standard Specification for Asphalt-Saturated Organic Felt Used

in Roofing and Waterproofing

s. ASTM E 2129 Standard Practice for Data Collection for Sustainability Assessment of Building Products

1.1.1.3 MARBLE INSTITUTE OF AMERICA (MIA)

a. MIA Design Manual Dimension Stone Design Manual

1.1.1.4 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a. NFPA 99 Health Care Facilities

1.1.1.5 TILE COUNCIL OF AMERICA (TCA)

a. TCA Hdbk Handbook for Ceramic Tile Installation

1.1.1.6 U.S. GREEN BUILDING COUNCIL (USGBC)

a. LEED Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.1.1.7 U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

a. 36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Detail Drawings

(1) Drawings showing ceramic tile pattern.

1.2.1.2 SD-03 Product Data

a. Local/Regional Materials; (LEED if required in the Scope of Work/Statement of Objectives)

(1) Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

b. Environmental Data

c. Tile

d. Setting-Bed

e. Mortar, Grout, and Adhesive; (LEED if required in the Scope of Work/Statement of Objectives)

(1) Manufacturer's catalog data and preprinted installation and cleaning instructions. Indicate VOC content.

f. Tile; (LEED if required in the Scope of Work/Statement of Objectives)

g. Reinforcing Wire Fabric; (LEED)

(1) Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

1.2.1.3 SD-04 Samples

a. Tile

b. Accessories

c. Marble Thresholds

d. Grout

(1) Samples of sufficient size to show color range, pattern, type and joints.

1.2.1.4 SD-06 Test Reports

a. Testing

(1) Copy of results for electrical resistance tests.

1.2.1.5 SD-07 Certificates

a. Tile

b. Mortar, Grout, and Adhesive

(1) Certificates indicating conformance with specified requirements. Furnish a master grade certificate for tile.

1.2.1.6 SD-11 Closeout Submittals

a. Local/Regional Materials; (LEED if required in the Scope of Work/Statement of Objectives)

(1) LEED documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

b. Tile; (LEED if required in the Scope of Work/Statement of Objectives)

c. Reinforcing Wire Fabric; (LEED if required in the Scope of Work/Statement of Objectives)

(1) LEED documentation relative to recycled content credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

d. Adhesives; (LEED if required in the Scope of Work/Statement of Objectives)

(1) LEED documentation relative to low-emitting materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

1.3 DELIVERY AND STORAGE

1.3.1 Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Protect materials from weather, and stored under cover in accordance with manufacturer's printed instructions.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Close space in which tile is being set to traffic and other work. Keep closed until tile is firmly set. Do not walk or work on newly tiled floors without using kneeling boards or equivalent protection of the tiled surface. Keep traffic off horizontal portland cement mortar installations for at least 72 hours. Keep all traffic off epoxy installed floors for at least 40 hours after grouting, and heavy traffic off for at least 7 days, unless otherwise specifically authorized by manufacturer.

1.4.2 Do not perform ceramic tile work unless the substrate and ambient temperature is at least 50 degrees F and rising. Maintain temperature above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used, ventilate the area to the outside to avoid carbon dioxide damage to new tilework.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

1.5.1.1 Local/Regional Materials

1.5.1.2 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.5.2 Environmental Data

1.5.2.1 Submit Table 1 of ASTM E 2129 for the indicated products.

1.6 WARRANTY

1.6.1 Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period.

1.7 EXTRA STOCK

1.7.1 Supply an extra five percent of each type tile used in clean and marked cartons.

1.8 DETAIL DRAWINGS

1.8.1 Dimension and draw detail drawings at a minimum scale of 1/4 inch = 1 foot. Include drawings of pattern at inside corners, outside corners, termination points and location of all equipment items such as thermostats, switch plates, mirrors and toilet accessories mounted on surface.

PART 2 PRODUCTS

2.1 TILE

2.1.1.1 Conform to ANSI A137.1 for standard grade tile. Provide grade sealed containers. Mark seals with the marks on the signed master grade certificate. Provide an impact resistant tile with a minimum floor breaking strength for wall tile of 90 pound and for floor tile of 250 pound in accordance with ASTM C 648. The manufacturer will provide a frost resistant rating for tile used in cold climate projects as determined by ASTM C 1026. Provide a 0.50 maximum

percent water absorption in accordance with ASTM C 373. Provide a minimum coefficient of friction of 0.50 wet and dry in accordance with ASTM C 1028. Identify floor tile as Class III-Medium Heavy IV Plus-Extra Heavy Traffic, durability classification as rated by the manufacturer when tested in accordance with ASTM C 1027 for abrasion resistance as related to foot traffic. Color shall be as indicated on the drawings or as selected. Tile shall contain a minimum of 5 percent post-consumer recycled content, or a minimum of 20 percent post-industrial recycled content, unless specified otherwise.

2.1.1.2 Mosaic Tile

a. Ceramic mosaic tile and trim shall be unglazed natural clay with cushion edges or porcelain with sharply formed face. Provide tile size as indicated. Color as indicated on the drawings or as selected.

2.1.1.3 Quarry Tile

a. Furnish an unglazed quarry tile and trim with smooth or abrasive surface as required. Quarry tile shall contain a minimum of 17 percent post-industrial recycled content. Use 6 by 6 by 1/2 inch. Color as indicated on the drawings or as selected.

2.1.1.4 Paver Tile

a. Furnish 4 by 4 by 3/8 inch, 6 by 6 by 3/8 inch, or 4 by 8 by 3/8 inch size paver tile made of low-fire clay, glazed with lead-free glaze. Color as indicated on the drawings or as selected.

2.1.1.5 Detectable Warning Tile

a. Furnish an unglazed detectable warning tile with raised truncated domes with a diameter of nominal 0.9 inch at a height of nominal 0.2 inch and a center-to-center spacing of nominal 2.35 inch that contrast visually with adjoining surfaces. Provide 6 by 6 by 1/2 inch tile. Color as indicated on the drawings or as selected.

2.1.1.6 Porcelain Tile

a. Furnish an unglazed porcelain tile and trim with the color extending uniformly through the body of the tile. Porcelain tile shall contain a minimum of 70 percent post-industrial content. Provide a nominal size as indicated. Criteria for tile to meet or exceed is as follows: Abrasive wear in accordance with ASTM C 501 and bonding strength in accordance with ASTM C 482. Comply with 36 CFR 1191 for coefficient of friction for interior tiled floors. Color as indicated on the drawings or as selected.

2.1.1.7 Glazed Wall Tile

a. Provide glazed wall tile with cushioned edges and trim edged with lead-free, bright or matte finish. Provide tile size as indicated. Color as indicated on the drawings or as selected.

2.1.1.8 Stone Tile or Stone Chip Tile

a. Tile shall be size as indicated. Color shall be as indicated on the drawings or as selected.

2.1.1.9 Accessories

a. Provide built-in type accessories of the same materials and finish as the wall tile. Provide accessories as indicated.

2.1.1.10 Tile Corners & Edges

a. Sanitary Cove: Provide sanitary cove for all wall to floor transitions. May be accomplished with factory formed tile or Schluter Systems DILEX-HK (or equal). Provide preformed 2-way interior corner tile or Schluter corner connectors. Provide preformed outside corner tile or Schluter connectors.

b. Interior Wall Corners: Provide sealant matching grout color at all internal corners. Schluter Systems DILEX-EKE in color matching grout is acceptable.

c. Exterior Wall Corners: Provide Schluter Systems RONDEC in clear anodized aluminum, or equal. Provide end caps for applications not extending to ceiling.

2.2 SETTING-BED

2.2.1 Compose the setting-bed of the following materials:

2.2.1.1 Aggregate for Concrete Fill

a. Conform to ASTM C 33 for aggregate fill. Do not exceed one-half the thickness of concrete fill for maximum size of coarse aggregate.

2.2.1.2 Portland Cement

a. Conform to ASTM C 150 for cement, Type I, white for wall mortar and gray for other uses.

2.2.1.3 Sand

a. Conform to ASTM C 144 for sand.

2.2.1.4 Hydrated Lime

a. Conform to ASTM C 206 for hydrated lime, Type S or ASTM C 207, Type S.

2.2.1.5 Metal Lath

a. Conform to ASTM C 847 for flat expanded type metal lath, and weighing a minimum 2.5 pound/square yard.

2.2.1.6 Reinforcing Wire Fabric

a. Conform to ASTM A 185 for wire fabric. Provide 2 by 2 inch mesh, 16/16 wire or 1-1/2 by 2 inch mesh, 16/13 wire. Wire fabric may contain post-consumer or post-industrial recycled content.

2.3 WATER

2.3.1 Provide potable water.

2.4 MORTAR, GROUT, AND ADHESIVE

2.4.1 Interior adhesives, sealants, primers and sealants used as filler must meet the requirements of LEED low emitting materials credit.

2.4.1.1 Dry-Set Portland Cement Mortar

a. ANSI/CTI A108/A118/A136.1. Zero-volatile organic compound (VOC) content.

2.4.1.2 Conductive Dry-Set Mortar

a. ANSI/CTI A108/A118/A136.1. Zero-VOC content.

2.4.1.3 Latex-Portland Cement Mortar

a. ANSI/CTI A108/A118/A136.1. Zero-VOC content.

2.4.1.4 Ceramic Tile Grout

a. ANSI/CTI A108/A118/A136.1; petroleum-free and plastic-free sand portland cement grout, dry-set grout, latex-portland cement grout, or commercial portland cement grout. Maximum VOC content of 150 grams/liter.

2.4.1.5 Organic Adhesive

a. ANSI/CTI A108/A118/A136.1, Type I. Water-resistant. Comply with applicable regulations regarding toxic and hazardous materials, and as specified. Tile adhesive shall have a maximum VOC content of 65 grams/liter.

2.4.1.6 Epoxy Resin Grout

a. ANSI/CTI A108/A118/A136.1. Prohibited unless specifically indicated otherwise.

2.4.1.7 Furan Resin Grout

a. ANSI/CTI A108/A118/A136.1 and consist of an intimate mixture of furfuryl-alcohol resin with carbon filler and catalyst. Prohibited unless specifically indicated otherwise.

2.4.1.8 Sealants

a. Comply with applicable regulations regarding toxic and hazardous materials and as specified. Single-component polyurethane sealant shall have a zero-VOC content. Two-component polyurethane sealant shall have a maximum VOC content of 45 grams/liter.

2.4.1.9 Cementitious Backer Board

a. Provide cementitious backer units, for use as tile substrate. Furnish 1/2 inch thick cementitious backer units unless otherwise indicated.

2.5 MARBLE THRESHOLDS

2.5.1 Provide marble thresholds of size required by drawings or conditions. Categorize marble Group A as classified by MIA Design Manual. Provide a fine sand-rubbed finish marble with white or gray in color as approved by the Contracting Officer. Provide minimum 12.0 marble abrasion when tested in accordance with ASTM C 241.

2.6 MEMBRANE MATERIALS

2.6.1 Conform to ASTM D 226, Type 1 for 15 pound waterproofing membrane, asphalt-saturated building felt. Conform to ASTM D 2103 4 mil for polyethylene film.

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

3.1.1 Opening Control Joint: Provide standard width sealant joint at the top edges of all door frames to ceiling above. Sealant shall match grout. Coordinate layout of tile at opening prior to installation. Provide joint in tile backer at same locations.

3.1.2 Extend wall tile finishes above any lay-in ceiling location. Attach perimeter ceiling wall track thru tile after installation of grout.

3.1.3 Inspect surface to receive tile in conformance to the requirements of ANSI/CTI A108/A118/A136.1 for surface conditions for the type setting bed specified and for workmanship. Provide variations of tiled surfaces that fall within maximum values shown below:

3.1.3.1 TYPE	WALLS	FLOORS
Dry-Set Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Organic Adhesives	1/8 inch in 8 ft.	1/16 inch in 3 ft.
Latex Portland Cement Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Epoxy	1/8 inch in 8 ft.	1/8 inch in 10 ft.

3.2 GENERAL INSTALLATION REQUIREMENTS

3.2.1 Do not start tile work until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Do not start floor tile installation in spaces requiring wall tile until after wall tile has been installed. Apply tile in colors and patterns indicated in the area shown on the drawings. Install tile with the respective surfaces in true even planes to the elevations and grades shown. Provide special shapes as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Solidly back tile bases and coves with mortar. Cut edges shall be smoothed with a tile stone prior to installation.

3.3 INSTALLATION OF WALL TILE

3.3.1 Install wall tile in accordance with the TCA Hdbk, method as indicated on the drawings or as selected.

3.3.1.1 Workable or Cured Mortar Bed

a. Install tile over workable mortar bed or a cured mortar bed at the option of the Contractor. Install a 4 mil polyethylene membrane, metal lath, and scratch coat. Conform to ANSI/CTI A108/A118/A136.1 for workable mortar bed, materials, and installation of tile. Conform to ANSI/CTI A108/A118/A136.1 for cured mortar bed and materials.

3.3.1.2 Dry-Set Mortar and Latex-Portland Cement Mortar

a. Use Dry-set or Latex-Portland Cement to install tile in accordance with ANSI/CTI A108/A118/A136.1. Use Latex Portland Cement when installing porcelain ceramic tile.

3.3.1.3 Organic Adhesive

a. Conform to ANSI/CTI A108/A118/A136.1 for the organic adhesive installation of ceramic tile.

3.3.1.4 Furan Mortar and Grout

a. Conform to ANSI/CTI A108/A118/A136.1 for furan mortar and grout installation.

3.4 INSTALLATION OF FLOOR TILE

3.4.1 Install floor tile in accordance with TCA Hdbk method as indicated on the drawings or as selected. Install shower receptors in accordance with TCA Hdbk method B414 or B415.

3.4.1.1 Workable or Cured Mortar Bed

a. Install floor tile over a workable mortar bed or a cured mortar bed at the option of the Contractor. Conform to ANSI/CTI A108/A118/A136.1 for workable mortar bed materials and installation. Conform to ANSI/CTI A108/A118/A136.1 for cured mortar bed materials and installation. Provide minimum 1/4 inch to maximum 3/8 inch joints in uniformed width.

3.4.1.2 Dry-Set and Latex-Portland Cement

a. Use dry-set or Latex-Portland cement mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with ANSI/CTI A108/A118/A136.1. Use Latex Portland cement when installing porcelain ceramic tile.

3.4.1.3 Resinous Grout

a. When resinous grout is indicated, grout quarry tile with either furan or epoxy resin grout. Rake and clean joints to the full depth of the tile and neutralize when recommended by the resin manufacturer. Install epoxy resin grout in conformance with ANSI/CTI A108/A118/A136.1. Install resin grout in accordance with manufacturer's printed installation instructions. Provide a coating of wax applied from the manufacturer on all tile installed and furan resin. Follow manufacturer's printed installation instructions of installed resin grout for proportioning, mixing, installing, and curing. Maintain the recommended temperature in the area and on the surface to be grouted. Protect finished grout of grout stain.

3.4.1.4 Ceramic Tile Grout

a. Prepare and install ceramic tile grout in accordance with ANSI/CTI A108/A118/A136.1.

3.4.1.5 Waterproofing

a. Shower pans are specified in Section 22 00 00 Plumbing, General Purpose. Conform to the requirements of Section 07 12 00 Built-Up Bituminous Waterproofing for waterproofing under concrete fill.

3.4.1.6 Concrete Fill

a. Provide a 3500 psi concrete fill mix to dry as consistency as practicable. Compose concrete fill by volume of 1 part Portland cement to 3 parts fine aggregate to 4 parts coarse aggregate, and mix with water to as dry a consistency as practicable. Spread, tamp, and screed concrete fill to a true plane, and pitch to drains or levels as shown. Thoroughly damp concrete fill before applying setting-bed material. Reinforce concrete fill with one layer of reinforcement, with the uncut edges lapped the width of one mesh and the cut ends and edges lapped a minimum 2 inch. Tie laps together with 18 gauge wire every 10 inch along the finished edges and every 6

inch along the cut ends and edges. Provide reinforcement with support and secure in the centers of concrete fills. Provide a continuous mesh; except where expansion joints occur, cut mesh and discontinue across such joints. Provide reinforced concrete fill under the setting-bed where the distance between the under-floor surface and the finished tiles floor surface is a minimum 2 inch, and of the same thickness that the mortar setting-bed over the concrete fill with the thickness required in the specified TCA Hdbk method.

3.5 INSTALLATION OF CONDUCTIVE FLOORING

3.5.1 Install conductive ceramic mosaic tile floors in accordance with ANSI/CTI A108/A118/A136.1.

3.6 INSTALLATION OF MARBLE THRESHOLDS

3.6.1 Install thresholds where indicated, in a manner similar to that of the ceramic tile floor. Provide thresholds full width of the opening. Install head joints at ends not exceeding 1/4 inch in width and grouted full.

3.7 TESTING

3.7.1 Perform electrical resistance tests on conductive flooring, in the presence of the Contracting Officer, by a technician experienced in such work. Furnish a copy of the test results. Provide test procedures, testing apparatus, and test results in accordance with the provisions for Conductive Flooring in NFPA 99.

3.8 EXPANSION JOINTS

3.8.1 Form and seal joints as specified in Section 07 92 00 Joint Sealants.

3.8.1.1 Walls

a. Provide expansion joints at control joints in backing material. Wherever backing material changes, install an expansion joint to separate the different materials.

3.8.1.2 Floors

a. Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs. Provide expansion joints where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 24 to 36 feet each way in large interior floor areas and 12 to 16 feet each way in large exterior areas or areas exposed to direct sunlight or moisture. Extend expansion joints through setting-beds and fill.

3.9 CLEANING, SEALING, AND PROTECTING

3.9.1 Upon completion, thoroughly clean tile surfaces in accordance with manufacturer's approved cleaning instructions. Do not use acid for cleaning glazed tile. Clean floor tile with resinous grout or with factory mixed grout in accordance with printed instructions of the grout manufacturer. After the grout has set, provide a protective coat of a noncorrosive soap or other approved method of protection for tile wall surfaces. Install sealant for floor tile grout in accordance with manufacturer’s recommendations. Cover tiled floor areas with building paper before foot traffic is permitted over the finished tile floors. Provide board walkways on tiled

floors that are to be continuously used as passageways by workmen. Replace damaged or defective tiles.

3.10 WASTE MANAGEMENT

3.10.1 Separate waste, including metal and cardboard, in accordance with the Waste Management Plan and recycle or reuse. Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in designated containers and areas. Close and seal tightly partly used sealant and adhesive containers and store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in designated containers and areas and dispose of properly. Set aside and protect half-tile and larger offcuts and remainders for reuse by the Government. Crush broken tile, offcuts smaller than a half tile, and excess mortar and grout for use as mosaic, sub-base, or fill. Identify manufacturer's policy for collection or return of construction scrap, unused material, demolition scrap, and packaging material. Institute recycling to take advantage of manufacturer's programs. When such a service is not available, seek local recyclers to reclaim the materials.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 1008	Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
b.	ASTM A 167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
c.	ASTM A 489	Standard Specification for Carbon Steel Lifting Eyes
d.	ASTM A 641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
e.	ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
f.	ASTM B 633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
g.	ASTM C 423	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
h.	ASTM C 635	Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
i.	ASTM C 636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
j.	ASTM C 834	Latex Sealants
k.	ASTM E 119	Standard Test Methods for Fire Tests of Building Construction and Materials
l.	ASTM E 1264	Acoustical Ceiling Products
m.	ASTM E 1414	Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
n.	ASTM E 1477	Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
o.	ASTM E 580	Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint
p.	ASTM E 795	Mounting Test Specimens During Sound Absorption Tests
q.	ASTM E 84	Standard Test Method for Surface Burning Characteristics of

Building Materials

1.1.1.2 U.S. DEPARTMENT OF DEFENSE (DOD)

a. UFC 3-310-04 Seismic Design for Buildings

1.1.1.3 UNDERWRITERS LABORATORIES (UL)

a. UL Fire Resistance Fire Resistance Directory

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Approved Detail Drawings

(1) Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

1.2.1.2 SD-03 Product Data

a. Acoustical Ceiling Systems

(1) Manufacturer's data indicating percentage of recycle material in acoustic ceiling tiles to verify affirmative procurement compliance.

(2) Total weight and volume quantities of acoustic ceiling tiles with recycle material.

(3) Manufacturer's catalog for the following items showing UL classification of fire-rated ceilings giving materials, construction details, types of floor and roof constructions to be protected, and UL design number and fire protection time rating for each required floor or roof construction and acoustic ceiling assembly.

1.2.1.3 SD-04 Samples

a. Acoustical Units

b. Acoustic Ceiling Tiles

(1) Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

1.2.1.4 SD-06 Test Reports

a. Fire Resistive Ceilings

b. Ceiling Attenuation Class and Test

(1) Reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified fire endurance and sound transmission requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resistance may be submitted in lieu of test reports.

1.2.1.5 SD-07 Certificates

a. Acoustical Units

b. Acoustic Ceiling Tiles

(1) Certificate attesting that the mineral based acoustical units furnished for the project contain recycled material and showing an estimated percent of such material.

1.3 GENERAL REQUIREMENTS

1.3.1 Provide sound controlling units mechanically mounted on a ceiling suspension system for acoustical treatment. The unit size, texture, finish, and color must be as specified. Coordinate the whole ceiling system with other details, like the location of access panels and ceiling penetrations, etc., shown on the drawings. The Contractor is responsible for all associated labor and materials and for the final assembly and performance of the specified work and products. The location and extent of acoustical treatment must be as shown on the approved detail drawings. Coordinate with paragraph Reclamation Procedures for reclamation of mineral fiber acoustical ceiling panels to be removed from the job site.

1.3.1.1 Fire Resistive Ceilings

a. Rate acoustical ceiling systems, indicated as fire resistant, for fire endurance as specified when tested in accordance with ASTM E 119. Suspended ceiling must have been tested with a specimen roof or floor assembly representative of the indicated construction, including mechanical and electrical work within ceiling space openings for light fixtures, and air outlets, and access panels. Provide ceiling assembly rating as indicated. Provide acoustical units with a flame spread of 25 or less and smoke development of 50 or less when tested in accordance with ASTM E 84.

1.3.1.2 Ceiling Attenuation Class and Test

a. Provide a ceiling system with an attenuation class (CAC) of .35 minimum when determined in accordance with ASTM E 1414. Provide fixture attenuators over light fixtures and other ceiling penetrations, and provide acoustical blanket insulation adjacent to partitions, as required to achieve the specified CAC. Provide test ceiling continuous at the partition and assembled in the suspension system in the same manner that the ceiling will be installed on the project.

1.3.1.3 Ceiling Sound Absorption

a. Determine the Noise Reduction Coefficient (NRC) in accordance with ASTM C 423 Test Method.

1.3.1.4 Light Reflectance

a. Determine light reflectance factor in accordance with ASTM E 1477 Test Method.

1.4 DELIVERY AND STORAGE

1.4.1 Deliver materials to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Carefully handle and store materials in dry, watertight enclosures. Immediately before installation, store acoustical units for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

1.5.1 Maintain a uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent for 24 hours before, during, and 24 hours after installation of acoustical units.

1.6 SCHEDULING

1.6.1 Complete and dry interior finish work such as plastering, concrete and terrazzo work before ceiling installation. Complete mechanical, electrical, and other work above the ceiling line; install and start operating heating, ventilating, and air conditioning systems in order to maintain temperature and humidity requirements.

1.7 WARRANTY

1.7.1 Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period. Include an agreement to repair or replace acoustical panels that fail within the warranty period in the standard performance guarantee or warranty. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

1.8 EXTRA MATERIALS

1.8.1 Furnish spare tiles, from the same lot as those installed, of each color at the rate of 5% of tiles installed.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

2.1.1.1 Units for Exposed-Grid System A: Standard is Armstrong, Cortega 15/16” angled tegular 704, or equal.

a. One or more of the following types as indicated:

(1) III (non-asbestos mineral fiber with painted finish)

b. Flame Spread: Class A, 25 or less

c. Pattern: as selected.

d. Minimum NRC: 0.55

e. Minimum Light Reflectance Coefficient: 0.82 or greater.

f. Nominal size: as indicated.

g. Edge detail: Tegular

h. Finish: Factory-applied standard finish or color finish.

i. Minimum CAC: .33

2.1.1.2 Humidity Resistant Composition Units

a. Type: Non-asbestos mineral or glass fibers bonded with ceramic, moisture resistant thermo-setting resin, or other moisture resistant material and having a factory applied white paint finish. Provide panels that do not sag or warp under conditions of heat, high humidity or chemical fumes.

b. Flame Spread: Class: A, 25 or less.

c. Pattern: as selected.

d. Minimum NRC: Minimum 0.50 when tested on Mounting Type E-400 of ASTM E 795.

e. Minimum Light Reflectance Coefficient: LR-1, 0.75 or greater.

f. Nominal Size: 24 by 48 inch.

g. Edge Detail: Square.

2.2 SUSPENSION SYSTEM

2.2.1 Provide one of the following suspension systems as indicated:

2.2.1.1 15/16” standard white

2.2.2 Suspension system shall conform to ASTM C 635 for intermediate-duty systems. Provide surfaces exposed to view of one of the following as indicated:

2.2.2.1 aluminum or steel with a factory-applied white or color baked-enamel finish

2.2.3 Provide wall molding having a flange of not less than 15/16 inch. Provide inside and outside corner caps. Suspended ceiling framing system must have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. Provide a suspension system with a maximum deflection of 1/360 of the span length. Conform seismic details to the guidance in UFC 3-310-04 and ASTM E 580.

2.3 HANGERS

2.3.1 Provide hangers and attachment capable of supporting a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.3.1.1 Wires

a. Conform wires to ASTM A 641, Class 1, 12 gauge.

2.3.1.2 Straps

a. Provide straps of 1 by 3/16 inch galvanized steel conforming to ASTM A 653, with a light commercial zinc coating or ASTM A 1008 with an electrodeposited zinc coating conforming to ASTM B 633, Type RS.

2.3.1.3 Rods

a. Provide 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

2.3.1.4 Eyebolts

a. Provide eyebolts of weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A 489.

2.3.1.5 Masonry Anchorage Devices

a. Comply with ASTM C 636 for anchorage devices for eyebolts.

2.4 ACCESS PANELS & HIDDEN UTILITY COMPONENTS

2.4.1 Provide access panels that match adjacent acoustical units, designed and equipped with suitable framing and fastenings for removal and replacement without damage. Size panel to be not less than 12 by 12 inch or more than 12 by 24 inch.

2.4.1.1 Attach an identification plate of 0.032 inch thick aluminum, 3/4 inch in diameter, stamped with the letters "AP" and finished the same as the unit, near one corner on the face of each access panel.

2.4.1.2 Color Coding Scheme for Locating Hidden Utility Components: Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 11”x17”, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated: Yellow - gas, green - water etc.

2.5 ADHESIVE

2.5.1 Use adhesive as recommended by tile manufacturer.

2.6 FINISHES

2.6.1 Use manufacturer's standard textures, patterns and finishes as specified for acoustical units and suspension system members. Treat ceiling suspension system components to inhibit corrosion.

2.7 COLORS AND PATTERNS

2.7.1 Use colors and patterns for acoustical units and suspension system components as indicated on the drawings or as selected.

2.8 ACOUSTICAL SEALANT

2.8.1 Conform acoustical sealant to ASTM C 834, nonstaining.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Examine surfaces to receive directly attached acoustical units for uneveness, irregularities, and dampness that would affect quality and execution of the work. Rid areas, where acoustical units will be cemented, of oils, form residue, or other materials that reduce bonding capabilities of the adhesive. Complete and dry interior finish work such as plastering, concrete, and terrazzo work before installation. Complete and approve mechanical, electrical, and other work above the ceiling line prior to the start of acoustical ceiling installation. Provide acoustical work complete with necessary fastenings, clips, and other accessories required for a complete installation. Do not expose mechanical fastenings in the finished work. Lay out hangers for each individual room or space. Provide hangers to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Keep main runners and carrying channels clear of abutting walls and partitions. Provide at least two main runners for each ceiling span. Wherever required to bypass an object with the hanger wires, install a subsuspension system so that all hanger wires will be plumb.

3.1.1.1 Suspension System

a. Install suspension system in accordance with ASTM C 636 and as specified herein. Do not suspend hanger wires or other loads from underside of steel decking.

(1) Plumb Hangers

(a) Install hangers plumb and not pressing against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, provide hangers at a minimum of four hangers per fixture and located not more than 6 inch from each corner of each fixture.

(2) Splayed Hangers

(a) Where hangers must be splayed (sloped or slanted) around obstructions, offset the resulting horizontal force by bracing, countersplaying, or other acceptable means.

3.1.1.2 Wall Molding

a. Provide wall molding where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Secure wall molding not more than 3 inch from ends of each length and not more than 16 inch on centers between end fastenings. Provide wall molding springs at each acoustical unit in semi-exposed or concealed systems.

3.1.1.3 Acoustical Units

a. Install acoustical units in accordance with the approved installation instructions of the manufacturer. Ensure that edges of acoustical units are in close contact with metal supports, with each other, and in true alignment. Arrange acoustical units so that units less than one-half width are minimized. Hold units in exposed-grid system in place with manufacturer's standard hold-down clips, if units weigh less than 1 psf or if required for fire resistance rating.

3.1.1.4 Caulking

a. Seal all joints around pipes, ducts or electrical outlets penetrating the ceiling. Apply a continuous ribbon of acoustical sealant on vertical web of wall or edge moldings.

3.1.1.5 Adhesive Application

a. Wipe back of tile to remove accumulated dust. Daub acoustical units on back side with four equal daubs of adhesive. Apply daubs near corners of tiles. Ensure that contact area of each daub is at least 2 inch diameter in final position. Press units into place, aligning joints and abutting units tight and uniform without differences in joint widths.

3.2 CEILING ACCESS PANELS

3.2.1.1 Locate ceiling access panels directly under the items which require access.

3.3 CLEANING

3.3.1.1 Following installation, clean dirty or discolored surfaces of acoustical units and leave them free from defects. Remove units that are damaged or improperly installed and provide new units as directed.

3.4 RECLAMATION PROCEDURES

3.4.1.1 Neatly stack ceiling tile, designated for recycling by the Contracting Officer, on 4 by 4 foot pallets not higher than 4 foot. Panels must be completely dry. Shrink wrap and symmetrically stack pallets on top of each other without falling over.

END OF SECTION 09 51 00

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ASTM INTERNATIONAL (ASTM)

a.	ASTM D 4078	Water Emulsion Floor Polish
b.	ASTM D 5603	Rubber Compounding Materials - Recycled Vulcanizate Particulate Rubber
c.	ASTM E 648	Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
d.	ASTM F 1066	Standard Specification for Vinyl Composition Floor Tile
e.	ASTM F 1303	Sheet Vinyl Floor Covering with Backing
f.	ASTM F 1344	Rubber Floor Tile
g.	ASTM F 1482	Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring
h.	ASTM F 1700	Solid Vinyl Floor Tile
i.	ASTM F 1859	Rubber Sheet Floor Covering Without Backing
j.	ASTM F 1860	Rubber Sheet Floor Covering With Backing
k.	ASTM F 1861	Resilient Wall Base
l.	ASTM F 1869	Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
m.	ASTM F 1913	Vinyl Sheet Floor Covering Without Backing
n.	ASTM F 2034	Sheet Linoleum Floor Covering
o.	ASTM F 2169	Resilient Stair Treads
p.	ASTM F 2170	Determining Relative Humidity in Concrete Floor Slabs in situ Probes
q.	ASTM F 2195	Linoleum Floor Tile
r.	ASTM F 710	Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring

1.1.1.2 U.S. GREEN BUILDING COUNCIL (USGBC) (if required in the Scope of Work/Statement of Objectives)

a.	LEED	Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Resilient Flooring and Accessories

(1) Scaled drawings indicating patterns (including location of patterns and colors) and dimensions.

1.2.1.2 SD-03 Product Data

a. Resilient Flooring and Accessories

(1) Manufacturer's descriptive data.

b. Adhesives; (LEED) (if required in the Scope of Work/Statement of Objectives)

(1) Manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics. Provide Material Safety Data Sheets (MSDS) for all primers and adhesives to the Contracting Officer. Highlight VOC emissions.

c. Vinyl Composition Tile; (LEED) (if required in the Scope of Work/Statement of Objectives)

d. Sheet Vinyl Flooring; (LEED) (if required in the Scope of Work/Statement of Objectives)

e. Rubber Tile; (LEED) (if required in the Scope of Work/Statement of Objectives)

f. Rubber Sheet Flooring; (LEED) (if required in the Scope of Work/Statement of Objectives)

g. Solid Vinyl Tile; (LEED) (if required in the Scope of Work/Statement of Objectives)

h. Cement-Fiber Board; (LEED) (if required in the Scope of Work/Statement of Objectives)

(1) Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

i. Local/Regional Materials; (LEED) (if required in the Scope of Work/Statement of Objectives)

(1) Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

j. Sheet Linoleum

k. Linoleum Tile

(1) Documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

1.2.1.3 SD-04 Samples

a. Resilient Flooring and Accessories

(1) Three samples of each indicated color and type of flooring, base, mouldings, and accessories. Provide a minimum 2-1/2 by 4 inch sample.

1.2.1.4 SD-06 Test Reports

a. Moisture, Alkalinity and Bond Tests

(1) Copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

1.2.1.5 SD-08 Manufacturer's Instructions

a. Surface Preparation

b. Installation

(1) Manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

1.2.1.6 SD-10 Operation and Maintenance Data

a. Resilient Flooring and Accessories

(1) Data Package 1 in accordance with Section 01 78 23 Operation And Maintenance Data.

1.2.1.7 SD-11 Closeout Submittals

a. Local/Regional Materials; (LEED)

(1) LEED documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

b. Resilient Flooring and Accessories; (LEED)

(1) LEED documentation relative to recycled content credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

c. Adhesives; (LEED)

(1) LEED documentation relative to low-emitting materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

d. Sheet Linoleum; (LEED)

e. Linoleum Tile; (LEED)

1.3 DELIVERY AND STORAGE

1.3.1 Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area free from strong contaminant sources and residues with ambient air temperature maintained above 68 degrees F and below 85 degrees F, stacked according to manufacturer's recommendations. Remove resilient flooring products from packaging to allow ventilation prior to installation. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS. Do not store rubber surface products with materials that have a high capacity to absorb volatile organic compound (VOC) emissions. Do not store exposed rubber surface materials in occupied spaces. Do not store near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Maintain areas to receive resilient flooring at a temperature above 68 degrees F and below 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of 55 degrees F thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

1.5.1 Local/Regional Materials

1.5.1.1 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.6 SCHEDULING

1.6.1 Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

1.7.1 Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.8 EXTRA MATERIALS

1.8.1 Furnish extra flooring material of each color and pattern at the rate of 5% of flooring installed. Furnish extra wall base material composed of 20 linear feet of each type, color and pattern. Package all extra materials in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

PART 2 PRODUCTS

2.1 VINYL COMPOSITION TILE

2.1.1 Conform to ASTM F 1066 for vinyl-composition tile, Class 2, (through pattern tile), Composition 1, asbestos-free, 12 inch square and 1/8 inch thick. Provide color and pattern uniformly distributed throughout the thickness of the tile. Tile shall contain a minimum of 90 percent recycled material.

2.2 SHEET VINYL FLOORING

2.2.1 Conform to one of the following as indicated:

2.2.1.1 ASTM F 1303 for sheet vinyl flooring, Type I, Grade 1, Class A-non-asbestos formulated

fibrous backing or Class B-nonfoamed plastic backing (minimum wear layer thickness 0.020 inch and minimum overall thickness 0.080 inch) and a minimum 6 feet 12 feet wide.

2.2.1.2 ASTM F 1303, Type II, Grade 1, without backing (minimum wear layer thickness 0.080 inch and minimum overall thickness 0.080 inch), and a minimum 6 feet wide. Extend color and pattern through the total thickness of the material.

2.2.1.3 ASTM F 1303, Type II, Grade 1, Class A non-asbestos formulated fibrous backing or Class B nonfoamed plastic backing (minimum wear layer thickness 0.050 inch and minimum overall thickness 0.080 inch) and a minimum 6 feet wide. Extend color and pattern throughout the thickness of the wearlayer.

2.2.1.4 ASTM F 1913, (minimum wear layer thickness 0.075 inch and minimum overall thickness 0.075 inch) and a minimum 6 feet wide. Extend color and pattern through the total thickness of the material. Sheet vinyl flooring may contain post-consumer or post-industrial recycled content. As required, provide welding rods as recommended by the manufacturer for heat welding of joints.

2.3 RUBBER TILE

2.3.1 Conform to ASTM F 1344 for rubber tile Class 1 homogeneous, Type A (solid color) or Type B (through mottled), 24 inch square. Provide smooth or raised surface studs with chamfered edges. Provide 0.125 inch overall thickness. Rubber tile shall contain a minimum of 90 percent post-consumer recycled material. With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D 5603, fine mesh size particulate.

2.4 RUBBER SHEET FLOORING

2.4.1 Conform to ASTM F 1859 for rubber sheet flooring (flooring without backing), Type I homogeneous or ASTM F 1860 (flooring with backing), Type I homogeneous, minimum 36 inch wide. Provide smooth or embossed surface as indicated. Provide 0.100 inch overall thickness minimum. Rubber sheet flooring shall contain a minimum of 90 percent post-consumer recycled material. With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D 5603, fine mesh size particulate.

2.5 SOLID VINYL TILE

2.5.1 Conform to ASTM F 1700 for solid vinyl tile Class I monolithic (minimum wear layer thickness 0.125 inch and minimum overall thickness 0.125 inch, Type A (smooth). Provide 12 or 24 inch square tile as indicated. Tile shall contain a minimum of 90 percent recycled content.

2.6 SHEET LINOLEUM

2.6.1 Conform to ASTM F 2034 for linoleum consisting of a homogeneous layer of a mixture of linoleum cement (binder in linoleum consisting of a mixture of linseed oil, pine rosin, fossil, or other resins or rosins, or an equivalent oxidized oleoresinous binder), and/or wood flour, mineral fillers, and pigments bonded to a jute backing. Provide a minimum 6 feet wide and overall thickness not less than 0.080 inch for linoleum. Provide welding rods as recommended by the manufacturer for heat welding of joints.

2.7 LINOLEUM TILE

2.7.1 Conform to ASTM F 2195 for linoleum tile consisting of a homogeneous layer of a mixture of linoleum cement (binder in linoleum consisting of a mixture of linseed oil, pine rosin, fossil, or other resins or rosins, or an equivalent oxidized oleoresinous binder), and/or wood flour, mineral fillers, and pigments bonded to a jute backing. Provide square tiles a minimum 18 inch square and overall thickness 0.100 inch minimum for linoleum tile.

2.8 WALL BASE

2.8.1 Conform to ASTM F 1861 for wall base, Type TS (vulcanized thermoset rubber) or Type TP (thermoplastic rubber), Style shall be coved. Provide 4 or 6 inch high and a minimum 1/8 inch thick wall base. Furnish job formed corners in matching height, shape, and color. Ensure all corners are FULLY adhered to wall without gaps. Rubber shall contain a minimum of 90 percent post-consumer recycled material. With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D 5603, fine mesh size particulate.

2.9 INTEGRAL COVE BASE

2.9.1 Extend integral coved base for sheet vinyl and sheet linoleum flooring up the wall 4 or 6 inches. Provide a vinyl or clear anodized aluminum, square cap strip and vinyl, rubber, or wood fillet strip with a minimum radius of 3/4 inch for integral coved bases at perimeter and fixed vertical interruptions to flooring. Provide integral cove of the same material as flooring. Provide inside and outside corner protectors of colored anodized aluminum or clear anodized aluminum approved by flooring manufacturer.

2.10 STAIR TREADS, RISERS, AND STRINGERS

2.10.1 Conform to ASTM F 2169 for treads, risers, and stringers, Type TS (vulcanized thermoset rubber) or Type TP (thermoplastic rubber). Rubber shall contain a minimum of 90 percent post-consumer recycled material. With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D 5603, fine mesh size particulate. Conform to ASTM F 2169 for surface of treads Class 1 smooth, Class 2 raised stud or ribbed pattern and have Group 1 abrasive non-slip strip or Group 2 strip for visually impaired of contrasting color of abrasive material. Provide square or round nosing depending on stair construction. Provide either a one piece nosing/tread/riser or a two piece nosing/tread design with a matching coved riser.

2.11 MOULDING

2.11.1 Provide tapered mouldings of rubber or clear anodized aluminum in types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on moulding of maximum 1/4 inch. Provide bevel change in level between 1/4 and 1/2 inch with a slope no greater than 1:2.

2.12 ADHESIVES

2.12.1 Provide adhesives for flooring, base and accessories as recommended by the manufacturer and comply with local indoor air quality standards. Interior adhesives must meet the requirements of LEED low emitting materials credit (if required in the Scope of Work/Statement of Objectives).

2.13 SURFACE PREPARATION MATERIALS

2.13.1 Provide surface preparation materials, such as panel type underlayment, lining felt, and floor crack fillers as recommended by the flooring manufacturer for the subfloor conditions. Comply with ASTM F 1482 for panel type underlayment products. Use one of the following substrates:

2.13.1.1 Cement-fiber board: Portland cement, sand, recycled cellulose with a minimum of 5 percent post-consumer recycled content, or 20 percent post-industrial recycled content.

2.13.1.2 Plywood: As specified in Section 06 10 00 Rough Carpentry.

2.13.1.3 Concrete.

2.14 POLISH/FINISH

2.14.1 Furnish polish as recommended by the manufacturer and conform to ASTM D 4078.

2.15 CAULKING AND SEALANTS

2.15.1 Furnish caulking and sealants in accordance with Section 07 92 00 Joint Sealants.

2.16 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

2.16.1 Provide color, pattern and texture for resilient flooring and accessories as indicated on the drawings or selected from manufacturer's standard colors. Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide floor patterns as specified on the drawings. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern.

PART 3 EXECUTION

3.1 EXAMINATION/VERIFICATION OF CONDITIONS

3.1.1 Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer.

3.2 SURFACE PREPARATION

3.2.1 Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Flatten floor to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Prepare the surfaces of lightweight concrete slabs (as defined by the flooring manufacturer) as recommended by the flooring manufacturer. Comply with ASTM F 710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's recommended printed installation instructions. Comply with ASTM F 1482 for panel type underlayments. Before any work under

this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove from the slabs concrete curing and sealer compounds, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxers, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

3.3 MOISTURE, ALKALINITY AND BOND TESTS

3.3.1 Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests and comply with manufacturer's recommendations. Conduct moisture testing in accordance with ASTM F 1869 or ASTM F 2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations.

3.4 PLACING VINYL-COMPOSITION, LINOLEUM AND SOLID VINYL TILES

3.4.1 Install tile flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's directions. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary edge width as necessary to maintain full-size tiles in the field, but no edge tile with less than one-half the field tile size, except where irregular shaped rooms make it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe edge tile to walls and partitions after field flooring has been applied.

3.5 PLACING SHEET VINYL FLOORING

3.5.1 Install sheet vinyl flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Lay out sheets to minimize waste. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied. Provide chemically bonded or heat welded seams and edges of sheet vinyl flooring where shown on the drawings in accordance with the manufacturer's written installation instructions. Finish joints flush, free from voids, recesses, and raised areas. Install flooring with an integral coved base where indicated.

3.6 PLACING SHEET LINOLEUM FLOORING

3.6.1 Install sheet linoleum flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Lay out sheets to minimize waste. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied. Cut seams by overlapping or underscribing as recommended by the manufacturer. Finish joints flush,

free from voids, recesses, and raised areas. Install flooring with an integral coved base where indicated.

3.7 PLACING RUBBER TILE

3.7.1 Install rubber tile and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Vary width of edge tiles as necessary to maintain full-size tiles, except where irregular-shaped rooms makes it impossible. Cut flooring to fit around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied.

3.8 PLACING RUBBER SHEET FLOORING

3.8.1 Install rubber sheet flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut seams by overlapping or underscribing as recommended by the manufacturer. Lay out sheets to minimize waste. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied.

3.9 PLACING MOULDING

3.9.1 Provide moulding where flooring termination is higher than the adjacent finished flooring and at transitions between different flooring materials. When required, locate moulding under door centerline. Moulding is not required at doorways where thresholds are provided. Secure moulding with adhesive as recommended by the manufacturer. Prepare and apply adhesives in accordance with manufacturer's printed directions. Anchor aluminum moulding to floor surfaces as recommended by the manufacturer.

3.10 PLACING WALL BASE

3.10.1 Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners. Install base in full lengths, not cut pieces.

3.11 PLACING STAIR TREADS, RISERS, AND STRINGERS

3.11.1 Secure and install stair treads, risers, and stringers in accordance with manufacturer's printed installation instructions. Cover treads and risers to the full width of the stairs. Provide stairs wider than manufacturer's standard lengths with equal length pieces butted together to cover the treads. Include stringer angles on both the wall and banister sides, and landing trim for installation if required.

3.12 PLACING INTEGRAL COVED BASE

3.12.1 Install integral cove base. Form integral base by extending the flooring material in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Form integral coved base by extending the flooring material 4 or 6 inches onto the wall surface. Support cove by a filler. Provide a cap strip at the top of the base. Fill voids along the top edge of base at masonry walls with caulk.

3.13 CLEANING

3.13.1 Immediately upon completion of installation of flooring in a room or an area, dry/clean the flooring and adjacent surfaces to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions. No sooner than 5 days after installation, wash flooring with a nonalkaline cleaning solution, rinsed thoroughly with clear cold water, and, except for rubber flooring and stair treads, risers and stringers, vinyl and other flooring not requiring polish by manufacturer, given the number of coats of polish in accordance with manufacturer's written instructions. Clean and maintain all other flooring as recommended by the manufacturer.

3.14 WASTE MANAGEMENT

3.14.1 Separate offcuts and waste materials and reuse or recycle in accordance with the Waste Management Plan, keeping sheet materials larger than 2 square feet and tiles larger than 1/2 tiles separate for reuse. Identify manufacturer's policy for collection or return of construction scrap, unused material, demolition scrap, and/or packaging material. Shred scrap linoleum for composting on site. Place materials defined as hazardous or toxic waste in designated containers and dispose of properly. Close and seal tightly partly used sealant and adhesive containers and store protected in a well ventilated fire-safe area at moderate temperature.

3.15 PROTECTION

3.15.1 From the time of laying until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

***** END OF SECTION *****

PART 1 - GENERAL

1.1 SECTION INCLUDES:
- A. Prepare new surfaces to receive finishes.
- B. Finish surfaces as scheduled and described in this Section.
- C. Gypsum board joint preparation.

1.2 SUBMITTALS - Submit in accord with Section ~~01340~~: 00 01 02
- A. Product Data: Manufacturer's technical data describing material and application.
- B. Samples: Colors available for Contracting Officer's selection.
- C. Mock-up: When requested, prepare 12 x 12 inch samples of specified finishes. Apply finishes on identical type materials to which they will be applied on job.

1.3 SUMMARY
- A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.
  1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
  1. Prefinished items include the following factory-finished components:
     a. Acoustical wall panels.
     b. Toilet enclosures.
     c. Metal lockers.
     d. Elevator entrance doors and frames.
     e. Elevator equipment.
     f. Finished mechanical and electrical equipment.
     g. Light fixtures.

  2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
     a. Foundation spaces.
     b. Furred areas.
     c. Ceiling plenums.
     d. Utility tunnels.
     e. Pipe spaces.
     f. Duct shafts.
     g. Elevator shafts.

  3. Finished metal surfaces include the following:
     a. Anodized aluminum.
     b. Stainless steel.
     c. Chromium plate.
     d. Copper and copper alloys.
     e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:
   a. Valve and damper operators.
   b. Linkages.
   c. Sensing devices.
   d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing and/or reducing.

B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F in well ventilated area.

C. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.5 ENVIRONMENTAL REQUIREMENTS:

A. Do not apply finishes unless moisture contents of surfaces are below paint manufacturer's recommendations, if doubtful, measure moisture content of surfaces using an electronic moisture meter.

B. Ensure surface temperatures or the surrounding air temperature is above 40 degrees F before applying finishes. Minimum application temperatures for latex paints for interior work is 45 degrees F and 50 degrees F for exterior work. Minimum application temperature for varnish and lacquer finishes is 65 degrees F. Minimum temperature for epoxy type paints is 60 degrees F.

C. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.

D. Provide adequate lighting on surfaces to be finished.

1.6 PROTECTION:

A. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.

B. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

C. Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from site.

D. Remove or mask-off electrical plates, surface hardware, fittings and fastenings, prior to painting operations. If removed, carefully store, clean and replace these items at completion of work in each area. Do not use solvents to clean hardware that may remove permanent finishes.

1.7 QUALITY ASSURANCE:

A. Use only qualified painters for mixing and application of paint and coating; in acceptance or rejection of installed painting, no allowance will be made for lack of skill on part of painters.

B. Use of a "Tooke Dry Film Thickness Gage" may be used to check and verify dry mil thickness of paint applied, if question of adequate coverage arises.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS ARE:
- A. KELLY-MOORE
- B. PITTSBURG
- C. PRATT AND LAMBERT
- D. SHERWIN-WILLIAMS
- E. Products listed are SHERWIN-WILLIAMS. Contracting Officer approved equivalent of above manufacturers may be considered if they meet or exceed the quality specified for each use. Refer to finish schedule for colors. In some cases, colors from several manufacturers are listed. Match selected colors with supplied products.

2.2 MATERIALS:
- A. Paint, Varnish, Stain, Enamel, Lacquer, Epoxies, and Fillers: Provide first quality material, no second line products will be allowed.
- B. Paint Accessory Materials: (Linseed oil, shellac, turpentine and other materials not specifically indicated herein but required to achieve the finishes specified) of high quality and approved manufacturer.
- C. Paints: Ready-mixed except field catalysed coatings. Pigments fully ground maintaining a soft paste consistency, capable of readily and uniformly dispersed to a complete homogeneous mixture.
- D. Paints to have good flowing and brushing properties and be capable of dry or curing free of streaks or sags.
- E. Joint Compounds: ASTM C475, manufactured by USG, factory-prepackaged type formulated specifically for joint or application intended. Use moisture resistant type on moisture resistant boards and exterior soffits.
- F. Reinforcing Tape: Paper type; use fiberglass mesh type if recommended by gypsum board or joint compound manufacturer.

PART 3 - EXECUTION

3.1 GENERAL:
- A. Thoroughly examine surfaces scheduled for painting prior to commencement of work. Report in writing to Architect, any condition that may potentially affect proper application. Do not commence until defects have been corrected.
- B. Correct defects and deficiencies in surfaces which may adversely affect finish.
- C. Remove doors to paint door bottoms.

3.2 JOINT SEALANTS:
- A. Coordinated sealants for compatibility with finish materials. Refer to Section 07 92 00 - JOINT SEALANTS.
- B. Seal project interior and exterior until it is completely waterproof and acceptable in appearance by Architect.

3.3 PRIME COATS:
- A. Field priming will not be required on items delivered with prime or shop coats already applied.
- B. Prime surfaces not provided with factory furnished prime coat.

3.4 PRE-FINISHED PRODUCTS:

A. Field painting will not be required on items specified to be completely finished at factory, aluminum, copper, brass, bronze, and other nonferrous metal and exterior wall finish system unless specifically designated in Painting Schedule.

3.5 PREPARATION:

A. General: The following are general descriptions of surface preparation. Follow paint manufacturer's preparation recommendations for surface to be painted.
B. Mildew: Remove by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry completely.
C. Galvanized Metals: Remove surface contamination and oils from surfaces and wash with solvent.
D. Steel and Iron: Remove grease, rust, scale, dirt, and dust. Where heavy coatings of scale are evident, removed by wire brushing, sandblasting, or any other necessary method. Ensure steel surfaces are satisfactory before paint finishing.
E. Unprimed Steel Surfaces: Clean surfaces by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
F. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Paint after defects have been remedied.
G. Millwork and Miscellaneous Wood Items: Wipe off dust and grit prior to priming or sealing. Spot coat knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried and sand between coats.
H. Wall and Partition Preparation:
    1. Wall covering on new gypsum board partitions: Tape, bed, and float joints, sand joints smooth and apply vinyl wall covering.
    2. Paint on new gypsum board partitions: Tape, bed and float joints. Sand joints smooth and apply uniform texture over entire surface.

3.6 APPLICATIONS:

A. Apply each coat at proper consistency, rate of coverage, and dry mil thickness as described by manufacturer's recommendations.
B. Each coat of paint is to be slightly darker or lighter than preceding coat unless otherwise approved by Contracting Officer.
C. Sand lightly between coats to achieve required finish.
    1. The number of coats listed hereinafter is minimum requirements.
    2. Apply additional coats to prevent "bleed through" if necessary to provide acceptable appearance.
D. Do not apply finishes on surfaces that are not sufficiently dry.
E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.
F. Where clear finishes are required, ensure tint fillers match wood. Work fillers well into the grain before set. Wipe excess from surface.
G. Prime top and bottom edges of metal doors with one coat of enamel undercoat when they are to be painted. Finish coat top and bottom edges.
H. Prime top and bottom edges of wood doors with two coats of varnish when they are to receive a stain or clear finish. Prime after staining has been applied.

3.7 MECHANICAL AND ELECTRICAL EQUIPMENT:

A. Paint exposed mechanical equipment items not factory finished and are exposed in finished room areas.

1. Prime and paint insulated and bare pipes, gas meters and lines, insulated and bare ducts, hangers, brackets, collars and supports, when intended to be exposed in finished rooms, except where items are plated or covered with a prefinished coating.

B. Factory finish will not be considered final finish if it is not compatible with adjacent surface colors. Paint this equipment as directed by Contracting Officer.

C. Refer to mechanical and electrical Sections with respect to color coding identification banding of equipment, ducting, piping and conduit.

D. Remove grilles, covers, and access panels for mechanical and electrical systems from location and paint separately.

E. Finish paint primed equipment to color selected.

F. Paint circuit breaker boxes, panels, meter boxes, gas piping and gas regulators, conduits, and other wall mounted electrical items when exposed on building exterior and when exposed in finished interior areas. Match adjacent finish color.

G. Replace identification markings on mechanical or electrical equipment when painted over or spattered.

H. Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.

I. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

3.8 GYPSUM BOARD TAPE, BED AND FINISH:

A. Tape, fill, and sand joints, edges corners, openings and fixtures, to produce surface ready to receive surfaces finishes. Feather coats onto adjoining surfaces.

B. Gypsum Board Preparation Schedule:

1. Exposed to view interior partitions: GA “Level 4" preparation finish.
2. Mechanical, Janitor Rooms: GA “Level 3" preparation finish.
3. Above Ceilings not exposed to view: GA “Level 1" preparation finish.

C. Refer to paint schedule for required texturing.

3.9 CLEANING:

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed, or splattered.

B. During progress of work keep premises free from any unnecessary accumulation of tools, equipment, surplus materials, and debris.

C. Upon completion of work leave premises neat and clean, to the satisfaction of Contracting Officer.

3.10 EXTERIOR PAINTING AND FINISHING SCHEDULE:

A. Concrete, Concrete Block, Stucco, Stone and Brick.

1. Paint finish:
   a. One coat: Pro Mar Interior/Exterior Block Filler B25W25
   b. Two coats: Pro Mar Exterior Latex Satin B37W106

B. Metal Fabrications:

1. Paint finish:
   a. Touch up shop prime coat or,
   b. One coat: Ken-Kromik Universal Primer
   c. Two coats: SWP DTM Alkyd B55 Semi-Gloss

3.11 INTERIOR PAINTING AND FINISHING SCHEDULE:

A. Wood - (Casework, trim and other wood items) Paint Softwood and apply Transparent Finish to Hardwood unless otherwise indicated.
   1. Paint finish:
      a. One coat: ProMar White Lacquer Undercoat B44WT1
      b. Two coats: SW Pro-Classic Alkyd Semi-Gloss B34W220
   2. Transparent finish:
      a. One coat: Oil Stain A48
      b. One coat: Pro-Mar High Build Sanding Sealer
      c. One coat: Pro-Mar High Build Satin B44FT7

B. Gypsum Board:
   1. Texture:
      a. Medium “Orange Peel”
   2. Paint finish:
      a. One coat: Preprite High Build Primer B28W601
      b. Two coats: Pro Mar 400 Semi-Gloss
      c. Two coats: Pro Mar 400 Flat Wall Paint on ceilings

C. Metal Fabrications:
   1. Paint finish:
      a. Touch up shop applied primer; or,
      b. One coat: Kem Kromik Primer Brown B50NZ/W1 White
      c. Two coats: Pro Mar 400 Alkyd Semi-Gloss

D. Metal Deck - Including exposed joists, beams, conduit, sprinkler piping, ductwork, framing or supports, and other exposed metal items.
   1. Paint finish: Two coats - Super Save-Lite H-Tec Dry Fall B48W71

3.12 EXTRA STOCK:

A. Leave on premises, where directed by Contracting Officer, not less than one gallon of each color used.

B. Containers to be tightly sealed and clearly labeled for identification.

***** END OF SECTION *****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ALUMINUM ASSOCIATION (AA)

a. AA DAF-45 Designation System for Aluminum Finishes

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a. ASTM B 26 Standard Specification for Aluminum-Alloy Sand Castings

b. ASTM B 62 Standard Specification for Composition Bronze or Ounce Metal Castings

1.1.1.3 NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

a. NAAMM AMP 500 Metal Finishes Manual

1.1.1.4 UNITED FACILITIES CRITERIA

a. UFC 1-200-01 General Building Requirements

b. UFC 3-120-01 Air Force Sign Standard

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Approved Detail Drawings

(1) Drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message shall be included.

1.2.1.2 SD-03 Product Data

a. Modular Exterior Signage System

(1) Manufacturer's descriptive data and catalog cuts.

b. Installation

(1) Manufacturer's installation instructions and cleaning instructions.

c. Exterior Signage

(1) Exterior signage schedule in electronic media with spread sheet format. Spread sheet shall include sign location, sign type, and message.

1.2.1.3 SD-04 Samples

a. Exterior Signage

(1) One 12 inch length of framing for illuminated signs. One sample of each type of sign. Each sample shall consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Color samples for each material requiring color and 12 inch square sample of sign face color sample.

1.2.1.4 SD-10 Operation and Maintenance Data

a. Protection and Cleaning

(1) Maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified diagrams for the equipment as installed.

1.3 GENERAL

1.3.1 All exterior signage shall be provided by a single manufacturer. Exterior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed and related components for a complete installation. Recyclable materials shall conform to EPA requirements in accordance with Section 01 62 35 Recycled / Recovered Materials.

1.4 CHARACTER PROPORTIONS AND HEIGHTS

1.4.1 Letters and numbers on indicated signs for handicapped-accessible buildings shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted. For Air Force Bases, see UFC 3-120-01 Air Force Sign Standard.

1.5 QUALIFICATIONS

1.5.1 Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.6 DELIVERY AND STORAGE

1.6.1 Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.7 WARRANTY

1.7.1 Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.8 EXTRA STOCK

1.8.1 The Contractor shall provide extra interchangeable message panels and extra stock of message bars of each color and size for sign types and changeable message strips as indicated.

PART 2 PRODUCTS

2.1 DIMENSIONAL BUILDING LETTERS

2.1.1 Fabrication

2.1.1.1 Letters shall be fabricated from cast aluminum. Letters shall be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath & clear anodized or dark bronze anodized. Letters shall be packaged for protection until installation. Perimeter edge thickness shall be 3/4" minimum.

2.1.1.2 Building Number on Metal Panel or EIFS: Aluminum, dark bronze, 12” tall individual numbers. Helvetica bold font. Coordinate number location with Contracting Officer.

2.1.1.3 Building Address on Metal Panel or EIFS: Immediately below building number. Aluminum, dark bronze, 6” tall individual numbers & letters in upper/lower case. Helvetica medium font. Coordinate number & letter location with Contracting Officer.

2.1.1.4 Building Number on Brick/Colored CMU: Aluminum, clear anodized, 12” tall individual numbers. Helvetica bold font. Coordinate number location with Contracting Officer.

2.1.1.5 Building Address on Brick/Colored CMU: Immediately below building number. Aluminum, clear anodized, 6” tall individual numbers & letters in upper/lower case. Helvetica medium font. Coordinate number & letter location with Contracting Officer.

2.1.1.6 Justification is building/elevation dependent; coordinate with Contracting Officer prior to ordering. Left, center, & right have been used.

2.1.2 Mounting

2.1.2.1 Threaded studs or Steel U-bracket, cap screws, and expansion bolts of number and size as recommended by manufacturer, shall be used for concealed anchorage. Letters which project from the building line shall have stud spacer sleeves. Letters, studs, and sleeves shall be of the same material. Templates for mounting shall be supplied.

2.2 ANODIC COATING

2.2.1 Anodized finish shall conform to AA DAF-45 as indicated.

2.2.1.1 Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.

2.2.1.2 Integrated color anodized designation AA-M10-C22-A32, Architectural Class 0.4 to 0.7 mil.

2.2.1.3 Electrolytically deposited color - anodized designation AA-M10-C22-A34, Architectural Class II 0.4 to 0.7 mil.

2.3 SHOP FABRICATION AND MANUFACTURE

2.3.1 Factory Workmanship

2.3.1.1 Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical. Items specified to be galvanized shall be by hot-dip process after fabrication if practical. Galvanization shall be in accordance with ASTM A 123 and ASTM A 653, as applicable. Other metallic coatings of steel sheet shall be in accordance with ASTM A 924. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.

2.3.2 Dissimilar Materials

2.3.2.1 Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.3.3 Shop Painting

2.3.3.1 Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, shall be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete shall not be painted. Upon completion of work, damaged surfaces shall be recoated.

2.4 COLOR, FINISH, AND CONTRAST

2.4.1 Color shall be as indicated on the drawings or selected from manufacturers standard colors. Color listed is not intended to limit the selection of equal colors from other manufacturers. For buildings required to be handicapped-accessible, the characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Signs, plaques, or dimensional letters shall be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces shall not be installed until finishes on such surfaces have been

completed.

3.1.1.1 Anchorage

a. Anchorage and fastener materials shall be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.1.2 Protection and Cleaning

a. The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, the Contractor shall cover all project identification, directional, and other signs which may mislead the public. Covering shall be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business. Signs shall be cleaned, as required, at time of cover removal.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

a. AAMA 2604 — Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

1.1.1.2 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

a. ANSI Z97.1 — Safety Glazing Materials Used in Buildings

1.1.1.3 ASTM INTERNATIONAL (ASTM)

a. ASTM B 209 — Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

b. ASTM B 221 — Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

c. ASTM C 1036 — Standard Specification for Flat Glass

d. ASTM D 635 — Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Detail Drawings

(1) Drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included.

(2) Provide the Following Signs at each door

(a) NCO OFFICE (DOOR 3)

(b) BREAK ROOM (DOOR 5 AND 7)

(c) CLEAN STORAGE (DOOR 8)

(d) WOMENS LOCKER ROOM (DOOR 11)

(e) MENS LOCKER ROOM (DOOR 10)

(f) TOOL CRIB (DOOR 21)

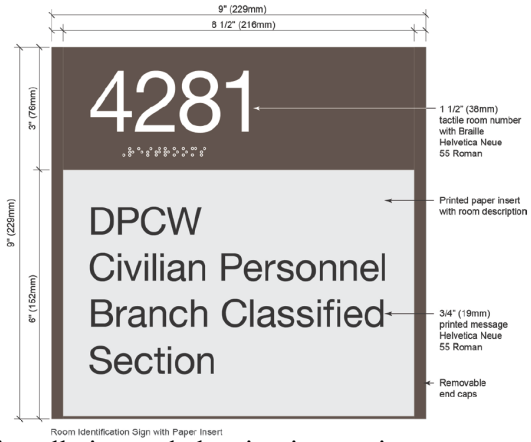
(g) STORAGE (DOOR 22)

(h) STENCIL ROOM (DOOR 34)

(i) PAINT STORAGE (DOOR 33)

(j) PAINT MIX ROOM (DOOR 32)

(k) TOOL CRIB (DOOR 30)



Room Identification Sign with Paper Insert

1.2.1.2 SD-03 Product Data

a. Installation

(1) Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

1.2.1.3 SD-04 Samples

a. Interior Signage

(1) One sample of each of the following sign types showing typical quality, workmanship and color. The samples may be installed in the work, provided each sample is identified and location recorded.

b. Directional sign.

c. Standard Room sign.

d. Changeable message strip sign.

1.2.1.4 SD-10 Operation and Maintenance Data

a. Approved Manufacturer's Instructions

b. Protection and Cleaning

(1) Operating instructions outlining the step-by-step procedures required for system operation shall be provided. The instructions shall include simplified diagrams for the system as installed. Copies of maintenance instructions listing routine procedures, repairs, and guides shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "Operating And Maintenance Instructions", name and location of the facility, name of the Contractor, and contract number.

1.3 GENERAL

1.3.1 Interior signage shall be of the design, detail, sizes, types, and message content shown on the drawings/attachments/signage placement schedule (as applicable), shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed and related components for a complete installation. Signage shall be obtained from a single manufacturer with edges and corners of finished letterforms and graphics true and clean. Air Force Base signage shall be in accordance with UFC 3-120-01, Air Force Sign Standard. Recyclable materials shall conform to EPA requirements in accordance with Section 01 62 35 Recycled / Recovered Materials.

1.3.2 Provide signage as required by ABA (Architectural Barriers Act) for all interior accessible locations.

1.4 QUALIFICATIONS

1.4.1 Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

1.5.1 Materials shall be packaged to prevent damage and deterioration during shipment, handling, storage and installation. Product shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 EXTRA STOCK

1.6.1 The Contractor shall provide extra frames and extra stock as indicated.

PART 2 PRODUCTS

2.1 ROOM IDENTIFICATION/DIRECTIONAL SIGNAGE SYSTEM

2.1.1 Standard Room Signs

2.1.1.1 Signage shall be one of the following:

2.1.1.2 Signs shall consist of acrylic plastic 0.080 inch thickness minimum conforming to ANSI Z97.1, laminated thermosetting Type MP plastic (three-ply melamine plastic laminate with phenolic core) or 6063-T5 extruded aluminum in accordance with ASTM B 221 and ASTM B 209 and shall conform to the following:

2.1.1.3 Units shall be frameless. Corners of signs shall be squared or rounded to radius indicated.

a. Changeable Message Strip Signs

(1) Changeable message strip signs shall be of same construction as standard room signs to include a clear sleeve that will accept a paper or plastic insert identifying changeable text. The insert shall be prepared die-cut vinyl letters applied to 0.015 inch rigid vinyl film, typewritten message photographically enlarged or used at actual size. Furnish paper and software for creating text and symbols for IBM compatible computers for Owner production of paper inserts after project completion. Sliding inserts or slide knobs that slide horizontally exposing different graphic information shall be provided as identified on the drawings. (For Room NCO Office – 3 provide changeable name plate)

b. Type of Mounting For Signs

(1) Extruded aluminum brackets shall be furnished for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs shall be by mechanical fasteners. Surface mounted signs shall be mounted with 1/16 inch thick vinyl foam tape or countersunk mounting holes in plaques and mounting screws fabricated from materials that are not corrosive to sign material and mounting surface.

c. Graphics

(1) Signage graphics for modular signs shall conform to one of the following:

(a) Subsurface copy: Copy is transferred to the back face of clear acrylic sheeting forming the panel face to produce precisely formed opaque image. This method bonds all sign elements (color, graphics, lettering, braille and substrate) into a single unit.

(b) Silkscreened First Surface Copy (non-tactile): Message shall be applied to panel using the silkscreen process. Silkscreened images shall be executed with photo screens prepared from original art. Handcut screens will not be accepted. Original art shall be defined as artwork that is a first generation reproduction of the specified art. This method is generally used for mass produced signs. Edges and corners shall be clean.

(c) Surface Applied Photopolymer: Integral graphics and braille achieved by photomechanical stratification processes. Photopolymer used for ADA compliant graphics shall be of the type that has a minimum durometer reading of 90. Tactile graphics must be raised 1/32 inch from the first surface of plaque by photomechanical stratification process.

(d) Engraved Copy: Machine engrave letters, numbers, symbols, and other graphics into panel sign on face to produce precisely formed copy and sharp images, incised to uniform depth. Melamine plastic engraving stock used for ADA compliant graphic shall be three-ply lamination contrasting color core meeting ASTM D 635

(e) Graphic Blast Raised Copy: Background is sandblasted to a uniform depth of 1/32 inch leaving raised text and Braille. Background shall be painted with polyurethane paint.

(f) Embossed: Methods other than sandblasting such as vacuum formed to create ADA compliant projected graphics.

(g) Cast, Fabricated, or Solid Aluminum Letters: 1/4 inch thick shall be provided and fastened to the message panel with concealed fasteners.

d. Character Proportions and Heights

(1) Letters and numbers on indicated signs which do not designate permanent rooms or spaces shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted. Suspended or projected overhead signs shall have a minimum character height of 3 inches.

e. Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms)

(1) Raised and brailled characters and symbols are only required on signs that designate permanent rooms or spaces, including restrooms and room numbers. They are not required for information or way-finding signs. Raised letters and numbers on signs must protrude 1/32 inch upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 5/8 inch in height, but no higher than 2 inches. Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 6 inches minimum in height. Indicated accessible facilities shall use the international symbol of accessibility.

2.2 FABRICATION AND MANUFACTURE

2.2.1 Factory Workmanship

2.2.1.1 Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.2.2 Dissimilar Materials

2.2.2.1 Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.3 COLOR, FINISH, AND CONTRAST

2.3.1 Color shall be as indicated on the drawings. Finish of all signs shall be eggshell, matte, or other non-glare finish as required in handicapped-accessible buildings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Signs shall be installed plumb and true and in accordance with approved manufacturer's instructions at locations shown on the drawings. Mounting height shall be 60 inch above the finish floor to the centerline of the sign. Distance from edge of door frame to edge of sign shall be as indicated on attachments. Required blocking shall be installed. Signs shall be installed on the wall adjacent to the latch side of the door. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall. Mounting location for such signage shall be so that a person may approach within 3 inches of signage without encountering protruding objects or standing within the swing of a door. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

3.1.1.1 Anchorage

a. Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish. Where recommended by signage manufacturer, foam tape pads may be used for anchorage. Foam tape pads shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 5 mil green flatstock treated with silicone. Foam pads shall be sized for the signage as per signage manufacturer's recommendations. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance. Signs mounted to lay-in ceiling grids shall be mounted with clip connections to ceiling tees.

3.1.1.2 Protection and Cleaning

a. The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall

be cleaned at completion of sign installation in accordance with the manufacturer's approved instructions.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ALUMINUM ASSOCIATION (AA)

a.	AA DAF-45	Designation System for Aluminum Finishes

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
b.	ASTM A 167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
c.	ASTM A 336	Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts
d.	ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
e.	ASTM B 221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
f.	ASTM B 456	Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
g.	ASTM B 86	Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings
h.	ASTM D 1972	Standard Practice for Generic Marking of Plastic Products
i.	ASTM D 2092	Standard Guide for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting

1.1.1.3 INTERNATIONAL CODE COUNCIL (ICC)

a.	ICC A117.1	Standard for Accessible and Usable Buildings and Facilities

1.1.1.4 SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

a.	SAE AMS-QQ-C-320	Chromium Plating (Electrodeposited)-FSC MFFP

1.1.1.5 U.S. GENERAL SERVICES ADMINISTRATION (GSA)

a.	CID A-A-60003	(Basic) Partitions, Toilet, Complete

1.1.1.6 U.S. GREEN BUILDING COUNCIL (USGBC)

a.	LEED	Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Installation Drawings

b. Fabrication Drawings

(1) Drawings showing plans, elevations, details of construction, hardware, reinforcing, fittings, mountings, and anchorings for metal partitions and urinal screens. Installation drawings as specified.

1.2.1.2 SD-03 Product Data

a. Toilet Partition System

b. Cleaning and Maintenance Instructions

c. Colors And Finishes

d. Galvanized Steel Sheet

e. Sound Deadening Cores

f. Partition Panels and Doors

g. Anchoring Devices and Fasteners

h. Hardware and Fittings

i. Brackets

j. Door Hardware

k. Ceiling-Hung Partitions

l. Floor-Anchored Partitions

m. Overhead-Braced Partitions

(1) Manufacturer's technical data and catalog cuts including installation and cleaning instructions.

n. Local/Regional Materials; (LEED) (LEED if required in the Scope of Work/Statement of Objectives)

(1) Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

o. Toilet Enclosures; (LEED) (LEED if required in the Scope of Work/Statement of Objectives)

p. Urinal Screens; (LEED)

(1) Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

1.2.1.3 SD-04 Samples

a. Colors and Finishes

(1) Manufacturer's standard color charts and color samples.

b. Partition Panels

(1) Three samples showing a finished edge on two adjacent sides and core construction, each not less than 12-inch square

c. Hardware and Fittings

d. Anchoring Devices and Fasteners

(1) Three samples of each item. Approved hardware samples may be installed in the work if properly identified.

1.2.1.4 SD-07 Certificates

a. Certification

(1) Documentation of product quality, as specified.

1.2.1.5 SD-10 Operation and Maintenance Data

a. Plastic Identification

(1) When not labeled, identify types in Operation and Maintenance Manual.

b. Waste Management

1.2.1.6 SD-11 Closeout Submittals (LEED if required in the Scope of Work/Statement of Objectives)

a. Local/Regional Materials; (LEED)

(1) LEED documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

b. Toilet Enclosures; (LEED)

c. Urinal Screens; (LEED)

(1) LEED documentation relative to recycled content credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

1.3 SYSTEM DESCRIPTION

1.3.1 Provide a complete and usable toilet partition system, including toilet enclosures, room entrance screens, urinal screens, system of panels, hardware, and support components. Comply with EPA requirements in accordance with Section 01 62 35 Recycled / Recovered Materials and Affirmative Procurement guidelines. Furnish the partition system from a single manufacturer, with a standard product as shown in the most recent catalog data. Submit Fabrication Drawings for metal toilet partitions and urinal screens consisting of fabrication and assembly details to be performed in the factory. Submit manufacturer's Cleaning and Maintenance Instructions with Fabrication Drawings for review.

1.4 REGULATORY REQUIREMENTS

1.4.1 Conform to ICC A117.1 code for access for the handicapped operation of toilet compartment

door and hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Deliver materials in the manufacturer's original unopened packages with the brand, item identification, and project reference clearly marked. Store Components in a dry location that is adequately ventilated; free from dust, water, other contaminants, and damage during delivery, storage, and construction.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

1.6.1.1 Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.6.2 Plastic Identification

1.6.2.1 Verify that plastic products to be incorporated into the project are labeled in accordance with ASTM D 1972. Where products are not labeled, provide product data indicating polymeric information in the Operation and Maintenance Manual.

a. Type 1: High Density Polyethylene (HDPE).

1.7 WARRANTY

1.7.1 Provide Certification or warranties that metal toilet partitions will be free of defects in materials, fabrication, finish, and installation and will remain so for a period of not less than three years after completion.

1.8 FIELD MEASUREMENTS

1.8.1 Take field measurements prior to the preparation of drawing and fabrication to ensure proper fits.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Anchoring Devices and Fasteners

2.1.1.1 Provide stainless steel anchoring devices and fasteners

2.1.2 Toilet Partitions: Provide 1” thick solid HDPE overhead braced toilet partitions, Scranton Products or equal, classic color collection, with stainless hardware & shoes, continuous brackets, aluminum headrails, 8” wrap around hinges, wall stops, & interior coat hooks.

2.1.3 Urinal Screens: Match toilet partitions. Provide floor supported mounting option.

2.2 PILASTER SHOES

2.2.1 Provide shoes at pilasters to conceal floor-mounted anchorage. Pilaster shoes shall be stainless steel. Shoes shall contain a minimum of 5 percent post-consumer recycled content, or a minimum of 20 percent post-industrial recycled content.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work. Verify correct spacing of plumbing fixtures. Verify correct location of built in framing, anchorage, and bracing. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the work of this section. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

3.2.1 Install partitions rigid, straight, plumb, and level, with the panels centered between the fixtures. Provide a panel clearance of not more than 1/2 inch and secure the panels to walls and pilasters with not less than two wall brackets attached near the top and bottom of the panel. Locate wall brackets so that holes for wall bolts occur in masonry or tile joints. Secure Panels to pilasters with brackets matching the wall brackets. Provide for adjustment due to minor floor variations. Locate head rail joints at pilaster center lines. Install adjacent components for consistency of line and plane. Equip each door with hinges, one door latch, and one coat hook and bumper. Align hardware to uniform clearance at vertical edges of doors. All doors shall be outswinging unless shown otherwise.

3.2.1.1 Secure panels to hollow plastered walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Toggle bolts must have a load-carrying strength of not less than 600 pounds per anchor.

3.2.1.2 Secure panels to ceramic tile on hollow plastered walls or hollow concrete-masonry walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Toggle bolts must have a load-carrying strength of not less than 600 pounds per anchor.

3.2.1.3 Secure panels to solid masonry or concrete with lead or brass expansion shields designed for use with not less than 1/4-20 screws, with a shield length of not less than 1-1/2 inch. Expansion shields must have a load-carrying strength of not less than 600 pounds per anchor.

3.2.1.4 Submit Installation Drawings for metal toilet partitions and urinal screens showing plans, elevations, details of construction, hardware, reinforcing and blocking, fittings, mountings and escutcheons. Indicate on drawings the type of partition, location, mounting height, cutouts, and reinforcement required for toilet-room accessories.

3.2.1.5 Blocking: Provide 2x8 wood or 16-gauge x 6” wide sheet metal blocking for all toilet accessories and door hardware backing. Use fire retardant treated wood or sheet metal in fire rated wall assemblies. All blocking shall be verified prior to coverage by CO.

3.3 FINAL ADJUSTMENT

3.3.1 After completion of the installation, make final adjustments to the pilaster-leveling devices, door hardware, and other working parts of the partition assembly. Doors shall have a uniform vertical edge clearance of approximately 3/16 inch and shall rest open at approximately 30 degrees when unlatched.

3.4 CLEANING

3.4.1 Clean all surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner compliant with the manufacturer's recommended cleaning and protection from damage procedures until accepted. Remove all equipment, tools, surplus materials, and work debris from the site.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ALUMINUM ASSOCIATION (AA)

a. AA DAF-45 Designation System for Aluminum Finishes

1.1.1.2 ASTM INTERNATIONAL (ASTM)

a. ASTM A 167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

b. ASTM B 221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

c. ASTM D 256 Determining the Izod Pendulum Impact Resistance of Plastics

d. ASTM D 543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

e. ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

f. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

g. ASTM G 21 Determining Resistance of Synthetic Polymeric Materials to Fungi

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Corner Guards

b. Corner Guards

1.2.1.2 SD-04 Samples

a. Finish

(1) Submit samples indicating color and texture of materials requiring color and finish.

1.2.1.3 SD-06 Test Reports

a. Corner Guards

1.2.1.4 SD-07 Certificates

a. Corner Guards

1.3 DELIVERY AND STORAGE

1.3.1 Materials shall be delivered to the project site in manufacturer's original unopened containers with seals unbroken and labels and trademarks intact. Materials shall be kept dry, protected from weather and damage, and stored under cover. Materials shall be stored at approximately 70 degrees F for at least 48 hours prior to installation.

1.4 WARRANTY

1.4.1 Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 GENERAL

2.1.1 To the maximum extent possible, corner guards, door and door frame protectors, wall guards (bumper guards), wall panels and wall covering shall be the standard products of a single manufacturer and shall be furnished as detailed. Drawings show general configuration of products required, and items differing in minor details from those shown will be acceptable.

2.1.1.1 Resilient Material

a. Resilient material shall consist of high impact resistant extruded acrylic vinyl, polyvinyl chloride, or injection molded thermal plastic and shall conform to the following:

(1) Minimum Impact Resistance

(a) Minimum impact resistance shall be 18 ft-lbs/sq. inch when tested in accordance with ASTM D 256, (Izod impact, ft-lbs per sq inch notched).

(2) Fire Rating

(a) Fire rating shall be Class 1 when tested in accordance with ASTM E 84, having a maximum flame spread of 25 and a smoke developed rating of 450 or less. Material shall be rated self extinguishing when tested in accordance with ASTM D 635. Material shall be labeled and tested by an approved nationally known testing laboratory. Resilient material used for protection on fire rated doors and frames shall be listed by the testing laboratory performing the tests. Resilient material installed on fire rated wood/steel door and frame assemblies shall have been tested on similar type assemblies. Test results of material tested on any other combination of door/frame assembly will not be acceptable.

(3) Integral Color

(a) Colored components shall have integral color and shall be matched in accordance with SAE J1545 to within plus or minus 1.0 on the CIE-LCH scales.

(4) Chemical and Stain Resistance

(a) Materials shall be resistant to chemicals and stains reagents in accordance with ASTM D 543.

(5) Fungal and Bacterial Resistance

(a) Materials shall be resistant to fungi and bacteria in accordance with ASTM G 21, as applicable.

2.2 CORNER GUARDS

2.2.1 Stainless Steel Corner Guards

2.2.1.1 Stainless steel corner guards shall be fabricated of 0.0625 inch thick material conforming to ASTM A 167, type 302 or 304. Corner guards shall extend from floor to ceiling or be height as indicated. Corner guard shall be formed to dimensions shown. All exposed edges shall be smooth & free of sharp edges or points.

2.3 ADHESIVES

2.3.1 Adhesive for resilient material shall be in accordance with manufacturer’s recommendations.

2.4 COLOR

2.4.1 Color shall be as indicated on the drawings or as selected from manufacturer’s standard colors. Color listed is not intended to limit the selection of equal colors from other manufacturers.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Stainless Steel Corner Guards

3.1.1.1 Mount guards on external corners of interior walls, partitions and columns as per manufacturer's recommendations.

3.1.1.2 Where corner guards are installed on walls, partitions or columns finished with plaster or ceramic tile, anchor corner guards as indicated. Coat back surfaces of corner guards, where shown, with a non-flammable, sound deadening material. Corner guards shall overlap finish plaster surfaces.

a. Where corner guards are installed on exposed structural glazed facing tile units or masonry wall, partitions or columns, anchor corner guards to existing walls with 1/4 inch oval head stainless steel countersunk expansion or toggle bolts or anchor corner guards with four nominal 0.0516 inch thick, adjustable galvanized steel anchors, spaced as shown. Grout spaces solid between guards and backing with portland cement and sand mortar.

b. Where corner guards are installed on gypsum board, clean surfaces and anchor guards with a neoprene solvent-type contact adhesive specifically manufactured for use on gypsum board construction. Remove excess adhesive from the guard edges and allow to cure undisturbed for 24 hours.

3.1.1.3 For wall guards, space brackets at no more than 3 feet on centers and anchor to the wall in accordance with the manufacturer's installation instructions.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 ASTM INTERNATIONAL (ASTM)

a. ASTM C 1036 Standard Specification for Flat Glass

1.1.1.2 UNITED STATES ACCESS BOARD

a. ABA Americans with Disabilities Act and Architecture Barriers Act Accessibility Guidelines.

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.2.1.1 SD-03 Product Data

a. Finishes

b. Accessory Items

(1) Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

1.2.1.2 SD-04 Samples

a. Finishes

b. Accessory Items

(1) One sample of each accessory proposed for use. Incorporate approved samples into the finished work, provided they are identified and their locations noted.

1.2.1.3 SD-07 Certificates

a. Accessory Items

(1) Certificate for each type of accessory specified, attesting that the items meet the specified requirements.

1.2.1.4 SD-10 Operation and Maintenance Data

a. Electric Hand Dryer

(1) Complete copies of maintenance instructions listing routine maintenance procedures and possible breakdowns. Include repair instructions for simplified wiring and control diagrams and other information necessary for unit maintenance.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

1.4.1 Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

2.1.1 Toilet accessories shall be provided where indicated on the drawings or as required for a fully functional toilet room. Provide each accessory item shall be complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

2.1.1.1 Anchors and Fasteners

a. Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory.

2.1.1.2 Finishes

a. Except where noted otherwise, provide the following finishes on metal:

Metal	Finish
(1) Stainless steel	No. 4 satin finish
(2) Carbon steel, copper alloy, and brass	Chromium plated, bright

2.2 ACCESSORY ITEMS

2.2.1 Conform to the requirements for accessory items specified below.

2.2.1.1 Grab Bar (GB)

a. Provide an 18 gauge, 1-1/4 inch grab bar OD Type 304 stainless steel. Provide form and length for grab bar as indicated. Provide concealed mounting flange. Provide grab with satin finish. Furnish installed bars capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Allow 1-1/2 inch space between wall and grab bar.

2.2.1.2 Mirrors, Glass (MG)

a. Provide Type I transparent flat type, Class 1-clear glass for mirrors. Glazing Quality q1, 1/4 inch thick, conforming to ASTM C 1036. Coat glass on one surface with silver coating, copper protective coating, and mirror backing paint. Provide highly adhesive pure silver coating of a

thickness which provides reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, free of pinholes or other defects. Provide copper protective coating with pure bright reflective copper, homogeneous without sludge, pinholes or other defects, of proper thickness to prevent "adhesion pull" by mirror backing paint. Provide mirror backing paint with two coats of special scratch and abrasion-resistant paint and baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.2.1.3 Paper Towel Dispenser (PTD)

a. Provide one of the following as indicated or selected.

(1) Manual Dispenser: Provide paper towel dispenser constructed of a minimum .03 inch Type 304 stainless steel, surface or recessed mounted. Provide a towel compartment and a mirror door and liquid soap dispenser for each dispenser. Furnish tumbler key lock locking mechanism.

2.2.1.4 Combination Paper Towel Dispenser/Waste Receptacle (PTDWR)

a. Provide recessed or semi-recessed dispenser/receptacle with a capacity of 400 sheets of C-fold, single-fold, or quarter-fold towel. Design waste receptacle to be locked in unit and removable for service. Provide tumbler key locking mechanism. Provide waste receptacle capacity of 18 gallons. Fabricate a minimum 0.03 inch stainless steel welded construction unit with all exposed surfaces having a satin finish. Provide waste receptacle that accepts reusable liner standard for unit manufacturer.

2.2.1.5 Sanitary Napkin Disposer (SND)

a. Construct a Type 304 stainless steel sanitary napkin disposal with removable leak-proof receptacle for disposable liners. Provide fifty disposable liners of the type standard with the manufacturer. Retain receptacle in cabinet by tumbler lock. Provide disposer with a door for inserting disposed napkins, recessed, partition mounted, double access or surface mounted as indicated.

2.2.1.6 Shower Curtain (SC)

a. Provide shower curtain, size to suit conditions. Provide anti-bacterial nylon/vinyl fabric curtain. Furnish color as indicated on the drawings or as selected.

2.2.1.7 Shower Curtain Rods (SCR)

a. Provide Type 304 stainless steel shower curtain rods 1-1/4 inch OD by 0.049 inch minimum straight or bent as required to meet installation conditions.

2.2.1.8 Soap Dispenser (SD)

a. Provide soap dispenser surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps or lavatory mounted, liquid type consisting of a polyethylene tank with a minimum 32 fluid ounces holding capacity and a 6 inch spout length. Unit shall be refillable from the top.

2.2.1.9 Soap Holder (SH)

a. Provide surface mounted or recessed Type 304 stainless steel soap holder. Provide stainless

steel separate supports.

2.2.1.10 Shelf, Metal, Heavy Duty (SMHD)

a. Furnish a minimum 18 gauge stainless steel heavy duty metal shelf with hemmed edges. Provide shelves over 30 inches with intermediate supports. Provide minimum of 16 gauge supports, welded to the shelf, and spaced no more than 30 inches apart.

2.2.1.11 Shelf, Metal, Light Duty (SMLD)

a. Support light duty metal shelf between brackets or on brackets. Purpose of brackets is to prevent lateral movement of the shelf. Furnish shelf length as indicated. Provide stainless steel shelf and brackets.

2.2.1.12 Towel Bar (TB)

a. Provide stainless steel towel bar with a minimum thickness of 0.015 inch. Provide minimum 3/4 inch diameter bar, or 5/8 inch square. Provide satin finish.

2.2.1.13 Towel Pin (TP)

a. Provide towel pin with concealed wall fastenings, and a pin integral with or permanently fastened to wall flange with maximum projection of 4 inch. Provide bright polish satin finish.

2.2.1.14 Toilet Tissue Dispenser (TTD)

a. Furnish Type II - surface mounted or Type III - recess mounted toilet tissue holder with two rolls of standard tissue stacked vertically. Provide stainless steel, satin finish cabinet.

2.2.1.15 Waste Receptacle (WR)

a. Provide Type 304 stainless steel waste receptacle, designed for recessed or surface mounting. Provide reusable liner, of the type standard with the receptacle manufacturer. Provide a minimum 12 gal. capacity (min.). Provide receptacles with push doors and doors for access to the waste compartment with continuous hinges.

2.2.1.16 Electric Hand Dryer (EHD)

a. Provide wall mount and electric hand dryer designed to operate at 110/125 volts, 60 cycle, single phase alternating current with a heating element core rating of a maximum 2100 watts. Provide dryer housing of single piece construction and of white porcelain enamel, chrome plated steel or baked electrostatically applied epoxy as indicated.

2.2.1.17 Diaper Changing Station (DCS)

a. Provide surface mounted diaper changing station fabricated of high impact plastic with no sharp edges. Provide fold down platform concave to the child's shape, equipped with nylon and velcro safety straps and engineered to withstand a minimum static load of 340 lb. Provide an integral dispenser for sanitary liners for each unit. Provide pictorial for universal use of safety graphics. Furnish color as selected. ADA compliant.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. Use sealants for brackets, plates, anchoring devices and similar items in showers (a silicone or polysulphide sealant) as they are set to provide a watertight installation. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

3.1.1.1 Recessed Accessories

a. Fasten accessories with wood screws to studs, blocking or rough frame in wood construction. Set anchors in mortar in masonry construction. Fasten to metal studs or framing with sheet metal screws in metal construction.

3.1.1.2 Surface Mounted Accessories

a. Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with sheet metal screws or wood screws in lead-lined braided jute, Teflon or neoprene sleeves, or lead expansion shields, or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs or to solid wood blocking secured between wood studs, or to metal backplates secured to metal studs.

3.2 CLEANING

3.2.1 Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 INTERNATIONAL CODE COUNCIL (ICC)

a. IFC 1414 Portable Fire Extinguishers (Where Required) (Construction, Alteration, Demolition)

b. IFC 906 Portable Fire Extinguishers

1.1.1.2 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a. NFPA 1 Uniform Fire Code

b. NFPA 10 Standard for Portable Fire Extinguishers

c. NFPA 101 Life Safety Code

1.1.1.3 U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

a. 29 CFR 1910.106 Flammable and Combustible Liquids

b. 29 CFR 1910.157 Portable Fire Extinguishers

1.1.1.4 UNDERWRITERS LABORATORIES (UL)

a. UL 154 Standards for Carbon Dioxide Fire Extinguishers

b. UL 2129 Standards for Halocarbon Clean Agent Fire Extinguishers

c. UL 299 Standards for Dry Chemical Fire Extinguishers

d. UL 626 Standards for Water Fire Extinguishers

e. UL 8 Standards for Water Base Agent Fire Extinguishers

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-01 Preconstruction Submittals

a. Manufacturer's Data for each type of required Fire Extinguisher with all related details, cabinets, accessories, and recommended operation manuals.

1.2.1.2 SD-02 Shop Drawings

a. Submit fabrication drawings for the following items consisting of fabrication and assembly details to be performed in the factory. Submit installation drawings for the following items in accordance with the paragraph entitled, "Installation," of this section.

(1) Fire Extinguishers

(2) Accessories

(3) Cabinets

(4) Wall Brackets

1.2.1.3 SD-03 Product Data

a. Submit Manufacturer's catalog and warranty data for the following items:

(1) Fire Extinguishers

(2) Accessories

(3) Cabinets

(4) Wall Brackets

(5) Replacement Parts

1.2.1.4 SD-04 Samples

a. One Fire Extinguisher of each type to be installed

b. One full-sized sample of each type of Cabinet to be installed

c. Three samples of Wall Brackets and Accessories of each type to be used

d. Approved samples may be used for installation, with proper identification and storage.

1.2.1.5 SD-07 Certificates

a. Submit Certificates showing the following:

b. Certification that Fire Extinguishers comply with local codes and regulations.

c. Certification that Fire Extinguishers comply with OSHA, NFPA, and UL requirements.

d. Submit Manufacturer's Warranty with Inspection Tag on each extinguisher.

e. Guarantee that Fire Extinguishers are free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than three years after completion.

1.3 DELIVERY, HANDLING, AND STORAGE

1.3.1 Protect materials from weather, soil, and damage during delivery, storage, and construction.

1.3.2 Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

1.3.3 Provide portable fire extinguishers in compliance with NFPA 505 for all ancillary vehicles where Fire Safety Standard for Powered Industrial Trucks, including type designations, special conditions relating to areas of use, conversions, maintenance, or specific operations apply.

PART 2 PRODUCTS

2.1 TYPES

2.1.1.1 1. Fire extinguishers shall be placed as required by NFPA 10 “Standard for Portable Fire Extinguishers.”

2.1.1.2 Wherever a tool house, storeroom, or other shanty is located in or adjacent to the building under construction or demolition, or where a room or space within that building is used for storage, a dressing room, or a workshop, at least one approved extinguisher shall be provided and maintained in a readily accessible location.

2.1.1.3 At least one approved fire extinguisher also shall be provided in plain sight on each floor at each usable stairway as soon as combustible material accumulates.

2.1.1.4 Suitable fire extinguishers shall be provided on self-propelled equipment.

2.1.1.5 Free unfettered access to permanent, temporary, or portable first aid fire equipment shall be maintained at all times. Submit Manufacturer's Data for each type of Fire Extinguisher required, detailing all related Cabinet, Wall Mounting and Accessories information, complete with Manufacturer's Warranty with Inspection Tag.

2.2 MATERIAL

2.2.1 Extinguisher shell must be corrosion-resistant steel, aluminum or enameled steel.

2.3 SIZE

2.3.1 Extinguishers shall be sized as indicated or as required by Fire Department.

2.4 CABINETS

2.4.1 Material

2.4.1.1 Provide enameled steel or aluminum cabinets.

2.4.2 Type

2.4.2.1 Provide cabinet type and style as indicated on the drawings or as selected

2.4.3 Size

2.4.3.1 Dimensions of cabinets must be of adequate size to accommodate the specified fire extinguishers.

2.5 WALL BRACKETS

2.5.1 Provide wall-hook fire extinguisher wall brackets.

2.5.2 Wall bracket and Accessories must be as approved.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Install Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

3.1.2 Comply with the manufacturer's recommendations for all installations.

3.1.3 Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

3.2 ACCEPTANCE PROVISIONS

3.2.1 Repairing

3.2.1.1 Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

3.2.1.2 Provide Replacement Parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

3.2.2.1 Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a. NFPA 701 Fire Tests for Flame Propagation of Textiles and Films

1.2 SUBMITTALS

1.2.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register.

1.2.1.1 SD-02 Shop Drawings

a. Hardware

b. Installation

(1) Drawings showing fabrication and installation details. Show layout and locations of track, direction of draw, mounting heights, and details.

1.2.1.2 SD-03 Product Data

a. Window Blinds

b. Hardware

c. Installation

(1) Manufacturer's data composed of catalog cuts, brochures, product information, and maintenance instructions.

1.2.1.3 SD-04 Samples

a. Window Blinds

b. Hardware

(1) Samples of each type and color of window treatment. Provide samples 6 inch in length for each color. Track must be 6 inch in length. Shade material must be minimum 6 by 6 inch in size.

1.2.1.4 SD-06 Test Reports

a. Window Blinds

(1) Fire resistance, Flame Spread, and smoke contribution data.

1.2.1.5 SD-08 Manufacturer's Instructions

a. Window Blinds

1.2.1.6 SD-10 Operation and Maintenance Data

a. Window Blinds

1.3 GENERAL REQUIREMENTS

1.3.1 Provide window treatment, conforming to NFPA 701, complete with necessary brackets, fittings, and hardware. Each window treatment type must be a complete unit provided in accordance with paragraph Window Treatment Placement Schedule. Mount and operate equipment as per manufacturer's instructions. Windows to receive a treatment must be completely covered.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 50 degrees F. Do not open containers until needed for installation unless verification inspection is required.

1.5 FIELD MEASUREMENTS

1.5.1 Become familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

1.6 WARRANTY

1.6.1 Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOW BLINDS

2.1.1 Provide each blind, including hardware, accessory items, mounting brackets and fastenings, as a complete unit produced by one manufacturer. All parts must be one color, unless otherwise indicated, to match the color of the blind slat. Treat steel features for corrosion resistance.

2.1.1.1 Horizontal Blinds

a. Provide horizontal blinds with 2 inch or 1 inch slats as indicated. Blind units must be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds must be inside or outside mount as indicated. Furnish tapes for Type I slats with longitudinal reinforced vinyl plastic in 1-piece turn ladder construction. Tapes for Type II slats must be braided polyester or nylon.

(1) Head Channel and Slats

(a) Provide head channel made of steel or aluminum with corrosion-resistant finish nominal 0.018 inch for Type I or 0.024 inch for Type II. Provide slats of aluminum,

not less than 0.008 inch thick, and of sufficient strength to prevent sag or bow in the finished blind. Provide a sufficient amount of slats to assure proper control, uniform spacing, and adequate overlap. Enclose all hardware in the headrail.

(2) Controls

(a) The slats must be tilted by a transparent tilting wand, hung vertically by its own weight, and must swivel for easy operation. The tilter control must be of enclosed construction. Provide moving parts and mechanical drive made of compatible materials which do not require lubrication during normal expected life. The tilter must tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. Include a mechanism to prevent over tightening. Provide a wand of sufficient length to reach to within 5 feet of the floor.

(3) Intermediate Brackets

(a) Provide intermediate brackets for installation, as recommended by the manufacturer, of blinds over 48 inches wide.

(4) Bottom Rail

(a) Provide bottom rail made of steel, corrosion-resistant, with baked-on polyester paint, color coordinated with slats, and formed with a double-lock seam into a closed oval shape for optimum strength. Provide end caps to match the rail in color.

(5) Braided Ladders

(a) Provide braided ladders of 100 percent polyester yarn of a color to match the slat color. Space ladders a maximum of and a minimum 15.2 slats per foot of drop in order to provide a uniform overlap of the slats in a closed position.

(6) Hold-Down Brackets

(a) Provide universal type hold-down brackets for sill or jamb mount where indicated on placement list.

(7) Audio Visual Blinds

(a) In addition to requirements for blinds, each unit must include light traps at sides, and sill. Furnish privacy blinds which provide light enhancing capabilities by means of hidden slat holes. Construct light traps from aluminum or sheet steel, not less than 0.02 inch thick, U-shaped, with legs not less than 1.75 inch long for Type I blinds or 0.75 inches long for Type II blinds. Round or bead edges in contact with blinds. Finish inside surfaces of light traps in a dull gray or black color.

2.2 COLOR

Provide color, pattern and texture as indicated on the drawings or as selected from manufacturer's standard colors. Color listed is not intended to limit the selection of equal colors from other manufacturers.

PART 3 EXECUTION

3.1 IDENTIFICATION

3.1.1 In accordance with the numbering plan, mark each opening and the corresponding window treatment with identical numbers. For multiple windows separated by mullions, the space required by each blind must be numbered separately. Use brass, aluminum, plastic, durable paper plates, or stamp to place corresponding numbers on unexposed surfaces of openings and inside or on top of the headrail track.

3.2 INSTALLATION

3.2.1 Horizontal Blinds

3.2.1.1 Perform installation in accordance with the approved detail drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Furnish and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.2.2 Audio Visual Blinds

3.2.2.1 Perform installation in accordance with the approved detail drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Furnish and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.3 CLEAN-UP

3.3.1 Upon completion of the installation, free window treatments from soiling, damage or blemishes; and adjust them for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure blinds installed in recessed pockets can be removable without disturbing the pocket. The entire blind, when retracted, must be contained behind the pocket. For blinds installed outside the jambs and mullions, overlap each jamb and mullion 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

***** END OF SECTION *****

PART 1 GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest published version and/or revision shall be used.

1.1.1.1 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

a.	AISC 303	Code of Standard Practice for Steel Buildings and Bridges
b.	AISC 360	Specification for Structural Steel Buildings, with Commentary
c.	AISC FCD	Quality Certification Program Description
d.	AISC S329	Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts

1.1.1.2 AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

a.	ASCE 7	Minimum Design Loads for Buildings and Other Structures

1.1.1.3 AMERICAN WELDING SOCIETY (AWS)

a.	AWS D1.1	Structural Welding Code - Steel

1.1.1.4 ASTM INTERNATIONAL (ASTM)

a.	ASTM A 1011	Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
b.	ASTM A 36	Standard Specification for Carbon Structural Steel

1.1.1.5 METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

a.	MBMA MBSM	Metal Building Systems Manual

1.1.1.6 SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

a.	SMACNA Arch. Manual	Architectural Sheet Metal Manual

1.1.1.7 STEEL DOOR INSTITUTE (SDI/DOOR)

a.	SDI/DOOR A250.8	Recommended Specification for Standard Steel Doors and Frames

1.1.1.8 UNDERWRITERS LABORATORIES (UL)

a.	UL 580	Tests for Uplift Resistance of Roof Assemblies

1.2 SYSTEM DESCRIPTION

1.2.1 Design Requirements

1.2.1.1 Design Analysis

a. The design analysis shall be the design of a licensed Professional Engineer experienced in design of this work and shall include complete calculations for the building, its components, and the foundations. Foundations shown on the drawings are based on loads derived from a representative set of similar building types. The Contractor shall obtain the services of a licensed Professional Engineer to verify that the foundations shown are adequate for the building supplied using the criteria in paragraph Foundations. Formulas and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. Wind forces on various parts of the structure, both positive and negative pressure, shall be calculated with the controlling pressure summarized. Lateral forces due to seismic loading shall be calculated and tabulated for the various parts and portions of the building. Computer programmed designs shall be accompanied by stress values and a letter of certification, signed by a licensed Professional Engineer, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included. Computer program output shall be annotated and supplemented with sketches to verify the input and output. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer, who shall function as a point of contact to answer questions during the detail drawing review.

1.2.1.2 Dimensions

a. Building dimensions shall be as standard with manufacturer, not less than those indicated, but exceeding the indicated dimensions only by the amount of the closest standard size thereto. Eave height shall be measured from the top of finished floor to intersection of insides of roof and sidewall sheets. The clear height between finished floor and bottom of roof steel shall be as indicated.

1.2.1.3 Framing

a. Provide building with vertical walls and roof configuration shown. Building shall be single-span single-span or multiple-span structures with one of the following framing systems: self-framing, column with single-span or continuous trusses, continuous beam frames, column with rigid frame, or rigid frame type, similar to AISC 360, Type I construction. End walls shall be of rigid frame beam and column design. Roof slope shall be a minimum of 1 to 24 or Roof slope greater than that indicated may be furnished if the required materials are provided and appropriate drawings are submitted and approved. Design framed openings structurally.

1.2.1.4 Foundation Requirements

a. Design foundations for allowable soil bearing pressure and a minimum bottom of footing depth as indicated. Use a factor of safety of 1.5 for overturning, sliding and uplift, and a concrete compressive strength as specified in Section 03 30 00 Cast-In-Place Concrete. The foundation loads are supplied by the building manufacturer.

1.2.2 Performance Requirements

1.2.2.1 MBMA MBSM, for loading combinations and definitions with the exceptions of wind load and

special collateral loads. Design for each material shall be as specified by the Design Authority as listed in MBMA MBSM.

a. Dead Loads

(1) The dead load shall consist of the weight of all permanent construction such as roof, framing, covering members and all other materials of the building system.

b. Roof Live Loads

(1) Uniform Loads: Uniform roof live loads, including maintenance traffic and construction loads, shall be determined and applied in accordance with ASCE 7.

(2) Concentrated Loads: In addition to ASCE 7 roof live loads, a minimum design concentrated load of 300 pounds shall be used to simulate a construction load on roof panels. The concentrated load shall be applied at the panel midspan and shall be resisted by a single standing seam metal roof panel, or a 24 inches wide corrugated metal panel, assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

c. Roof Snow Loads

(1) The design roof snow loads, including effects of drifting, shall be determined and applied in accordance with ASCE 7.

d. Wind Loads

(1) Compute and apply wind pressures, ASCE 7. Basic wind speed and multiplying factors are as indicated.

e. Impact Loads

(1) Impact loads due to monorails or cranes shall be applied as indicated in MBMA MBSM.

f. Seismic Loads

(1) As required for ground motion acceleration indicated.

g. Collateral Loads

(1) As indicated.

(2) Equipment loads of 50 pounds or more shall be shown on the shop (detail) drawings and the structure (frame, purlins, girts) shall be strengthened as required. The Contractor is responsible for providing the building manufacturer the magnitude and approximate location of all concentrated loads greater than 50 pounds before design of the building commences.

h. Deflection

(1) Structural Members: The maximum deflection of main framing members shall not exceed 1/240th of their respective spans. The maximum deflection due to live load in roof panels and purlins shall not exceed 1/180th of their respective spans.

(2) Roof Panels: UL 580, Class 90. The design analysis shall establish that the roof when deflected under dead plus live or snow loads, will not result in a negative gradient. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. In addition, the roof decking shall be designed for a 200-pound concentrated load at midspan on a 12 inch wide section of deck. Panels thinner than 0.03 inches are not permitted for diaphragms used to resist seismic loads in Seismic Zones 2 through 4.

(3) Wall Panels: The maximum deflection due to wind on wall panels and girts shall be limited to 1/120th of their respective spans except that when interior finishes are used the maximum allowable deflection shall be limited to 1/180th of their respective spans.

(4) Openings: Limit deflections of steel framing above and along the side of rolling door openings to a maximum of 1/2 the allowable movement in the telescoping top roller of the doors to ensure proper operation. Frame all equipment openings over 12 by 12 inches.

i. Provisions for Gutters and Downspouts

(1) Gutters and downspouts shall be designed according to the requirements of SMACNA Arch. Manual for storms which should be exceeded only once in 5 years and with adequate provisions for thermal expansion and contraction. Supports for gutters and downspouts shall be designed for the anticipated loads.

j. Provisions for Louvers

(1) Louvers shall be rainproof, and to resist vibration.

k. Ventilators

(1) Circular Ventilators: Circular roof ventilators shall be gravity type, with dampers as indicated.

(2) Continuous Ventilators: Continuous roof ventilators shall be ridge mounted gravity type, with dampers as indicated.

l. Drift Provisions

(1) Lateral deflections, or drift, at the roof level of a structure in relation to the floor or slab on grade, caused by deflection of horizontal force resisting elements, shall conform to MBMA MBSM.

m. Cranes

(1) The crane loads shall be obtained from the crane manufacturer and shall be applied per MBMA MBSM for the design of the crane runways and supports. Cranes with a capacity greater than 10 tons shall be supported by a structural system which is separate from the building frames except for lateral support. Flexible connections to the building columns, if used, shall allow the separate crane support system to resist longitudinal crane loads by other means without over stressing the building frame. Likewise, the building frame shall be free to deflect without over stress caused by connections to the more rigid crane support system.

1.3 SUBMITTALS

1.3.1 Government approval may be required on any of the following items. Items requiring submittals will be listed on the Submittal Register. Provide copies of all submittals per the requirements in Section 01 33 00, Submittal Procedures, or as listed on the Submittal Register.

1.3.1.1 SD-02 Shop Drawings

a. PreengineeredPre-engineered Building

b. Template for anchorage

(1) Submit as necessary to erect the building and install components.

1.3.1.2 SD-03 Product Data

a. PreengineeredPre-engineered metal building materials

(1) Submit sufficient data indicating conformance to specified requirements on materials provided under this section.

b. Instruction Manuals

c. Erection

d. Qualifications

1.3.1.3 SD-04 Samples

a. Factory color finish

b. Accessories

c. Roofing and Siding

d. Fasteners

e. Insulation

f. Gaskets and Insulating Compounds

g. Sealant

h. Skylights

i. Wall Liners

1.3.1.4 SD-05 Design Data

a. Building

b. Foundation loads

c. Anchor bolts

1.3.1.5 SD-06 Test Reports

a. Factory Color Finish

b. Insulation

1.3.1.6 SD-07 Certificates

a. PreengineeredPre-engineered metal building materials

(1) Submit certificates attesting that materials comply with this specification.

1.3.1.7 SD-10 Operation and Maintenance Data

a. PreengineeredPre-engineered Building, data package 1

(1) Submit in accordance with Section 01 78 23 Operation And Maintenance Data.

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Qualifications of the manufacturer, the manufacturer's Representative when one is used, and qualifications and experience of the building erector. A brief list of locations where buildings

of similar design have been used shall be included with the detail drawings and shall also include information regarding date of completion, name and address of owner, and how the structure is used.

a. Manufacturer

(1) The manufacturer shall have AISC FCD, category MB certification.

b. Installer

(1) Erector shall have specialized experience in the erection of metal building systems for a period of at least 3 years.

c. Manufacturer's Representative

(1) A representative designated by the building manufacturer, who is familiar with the design of the building supplied and experienced in the erection of metal buildings similar in size to the one required under this contract, shall be present at the job site during construction, from the start of the structural framing erection until completion of the installation of the exterior covering, to assure that the building is erected properly.

1.4.2 Regulatory Requirements

1.4.2.1 Drawings: PreengineeredPre-engineered Building

a. Submit complete design drawings for the preengineeredpre-engineered building. Submit drawings for the foundations and anchorage.

1.4.2.2 Design Data Building

a. Submit design calculations for the entire preengineeredpre-engineered building and foundations, prepared and stamped by a professional engineer. Also submit for components requested, and stamp with the seal of a professional engineer. Include sizes and location of anchor bolts.

1.4.3 Coordination Meeting

1.4.3.1 A coordination meeting shall be held within 45 days after contract award for mutual understanding of the metal building system contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roofing/metal building system manufacturer, the roofing/metal building supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

1.4.4 Instructions

1.4.4.1 Instruction Manuals

a. Manufacturer's literature for individual building component systems.

1.4.4.2 Erection

a. Manufacturer's erection instruction and erection drawings describing the preparation requirements, assembly sequence, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components.

1.4.5 Samples

1.4.5.1 Factory color Finish

a. Submit one sample of each color indicated for verification that the color matches the colors indicated. Where colors are not indicated, submit not less than four different samples of manufacturer's standard colors for selection by the Contracting Officer.

1.4.5.2 Accessories

a. One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

1.4.5.3 Roofing and Siding

a. One piece of each type and finish (exterior and interior) to be used, 9 inches long, full width. The sample for factory color finished covering shall be accompanied by certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish.

1.4.5.4 Fasteners

a. Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

1.4.5.5 Insulation

a. One piece of each type to be used, and descriptive data covering installation.

1.4.5.6 Gaskets and Insulating Compounds

a. Two samples of each type to be used and descriptive data.

1.4.5.7 Sealant

a. One sample, approximately 1 pound, and descriptive data.

1.4.5.8 Skylights

a. One piece, 9 inches long, full width.

1.4.5.9 Wall Liners

a. One piece, 9 inches long, full width.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Deliver, store, and handle manufactured items so that materials remain dry and undamaged. Do not store in contact with materials that might cause staining.

1.6 WARRANTIES

1.6.1 Warranty

1.6.1.1 The Metal Building System, composed of framing and structural members, roofing and siding, gutters and downspouts, accessories, fasteners, trim, and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer) shall be warranted as described below against material and workmanship deficiencies, system deterioration caused by exposure to the elements and service design loads, leaks and wind uplift damage. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.6.2 Prime Contractor's Weathertightness Warranty

1.6.2.1 The Metal Building System shall be warranted by the Contractor on a no penal sum basis for a period of five years against materials and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The Metal Building System covered under this warranty shall include but is not limited to the following: framing and structural members, roofing and siding panels and seams, interior or exterior gutters and downspouts, accessories, fasteners, trim, flashings and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer), connectors, components, and fasteners, and other system components and assemblies installed to provide a weathertight system; and items specified in other sections of these specifications that become part of the metal building system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's written warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and/or system manufacturer, which shall be submitted along with Contractor's warranty. However, the Contractor is ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached **WARRANTY FOR METAL BUILDING SYSTEMS,** and start upon final acceptance of the facility. The Contractor shall provide a separate bond in an amount equal to the installed total metal building system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire metal building system as outlined above.

1.6.3 Manufacturer's Material and/or System Weathertightness Warranties

1.6.3.1 The Contractor shall furnish, in writing, the following manufacturer's material warranties to the Contracting Officer which cover all Metal Building System components:

a. A manufacturer's 20 year material warranty warranting that the specified aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed securement system including fasteners and coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change colors in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2224. Liability under this warranty is exclusively limited to replacing the defective coated material.

PART 2 PRODUCTS

2.1 WALL AND ROOF MATERIALS

2.1.1 MBMA MBSM except as specified otherwise herein. Design roof and wall panels, accessories, and flashings to be completely weathertight and free of abrasions, loose fasteners, and deformations. Each piece or part of the assembly shall be clearly and legibly marked to correspond with the drawings.

2.1.1.1 Minimum Thickness

a. As required to conform to design requirements but not less than the following:

Items	Minimum Thickness (Uncoated)
(1) Steel Structural Members	
(a) Other Than Roof and Wall Panels	18 gage, 0.0478 inch
(2) Roof and Wall Panels	
(a) Steel	26 gage, 0.0179 inch
(b) Aluminum	0.032 inch
(c) Plastic	0.045 inch
(3) Gable and Eave Trim, Fascia Closure Strips, Rake Flashings, Copings, and Liner Panels	
(a) Steel	26 gage, 0.0179 inch
(b) Aluminum	0.032 inch
(c) Plastic	0.045 inch
(4) Interior Gutters	
(a) Steel	24 gage, 0.0239 inch
(b) Aluminum	0.040 inch
(5) Eave Gutters and Downspouts	
(a) Steel	26 gage, 0.0179 inch
(b) Aluminum	0.032 inch
(6) Roof Ventilators	
(a) Steel	26 gage, 0.0179 inch
(b) Aluminum	0.032 inch
(7) Louvers	
(a) Steel	18 gage, 0.0478 inch
(b) Aluminum	0.064 inch
(8) Girders and Columns	3/16 inch
(a) Purlins and Girts	14 gage
(9) Roof Panels	

(a) Steel 22 gage

(b) Aluminum 0.04 inch

(10) Wall Panels

(a) Steel 24 gage

(b) Aluminum 0.032 inch

(11) Bracing 3/16 inch thick steel members

(12) Column Base Plates 5/8 inch thick

(13) Column Anchor Bolts 5/8 inch diameter

(14) Gable and Eave Trim, Fascia Closure Strips, Rake Flashings, Copings, and

(15) Liner Panels

(a) Steel 24 gage

(b) Aluminum 0.032 inch

(c) Plastic 0.045 inch

(16) Interior Gutters

(a) Steel 24 gage

(b) Aluminum 0.040 inch

(17) Eave Gutters and Downspouts

(a) Steel 24 gage

(b) Aluminum 0.032 inch

(18) Louvers

(a) Steel 18 gage

(b) Aluminum 0.064 inch

2.1.1.2 Panels

a. Fabricated of zinc-coated steel aluminum/zinc-coated steel or aluminum except translucent wall panels indicated.

b. Factory-insulated to provide weathertight joint upon installation, with:

c. Inner and outer sheets formed and joined at edges into a tongue-and-groove joining system with vinyl seals, closed cell foam tape, or factory-applied nonskinning butyl sealant ; or

d. Outer sheet designed to overlap adjacent panel a minimum of one configuration.

e. If designed as diaphragm, roof decks shall be designed in accordance with SDI DDMO3.

f. For standing seam roofs, Section 07 61 14 Steel Standing Seam Roofing.

(1) Depth of the panels shall be as indicated. Insulation in the cores of the panels shall be asbestos-free composition and provide an overall "U" value of not more than 0.10 for wall panels and 0.05 for roof panels. Insulation in factory-insulated panels shall have a flame spread rating of 75 or less and a smoke development factor of 150 or less. Panels over 30 feet in length shall be designed for thermal expansion and contraction.

(a) Zinc-Coated Steel Sheet

1. ASTM A 755, Coating Class Z 350 (G-90) or ASTM A 653, SQ, Grade 33, Coating Class Z 350 (G-90).

(b) Aluminum/Zinc-Coated Steel Sheet

1. ASTM A 792, AZ 55

(c) Aluminum Sheet

1. Alloy 3004 Alclad conforming to ASTM B 209.

(d) Aluminum-coated Steel

1. ASTM A 463, Type Z, coating designation T2 ES; or aluminum-coated steel conforming to ASTM A 463, Type 2, coating designation T2 E5.

2.1.1.3 Wall Liners

a. Wall liners shall be 0.024 inch thick minimum for aluminum or 0.018 inch thick minimum for steel with the same composition specified for panels or siding, and formed or patterned to prevent waviness and distortion, and shall extend from floor to ceiling. Matching metal trim shall be provided at base of wall liner, at top of wall liner, around openings in walls and over interior and exterior corners. Wall liners shall have manufacturer's standard finishes. Colors shall be selected from manufacturer's standard finishes.

2.2 FRAMING AND STRUCTURAL MEMBERS

2.2.1 Steel

2.2.1.1 ASTM A 36, ASTM A 529, ASTM A 572, or ASTM A 588.

2.2.2 Aluminum

2.2.2.1 ASTM B 221 or ASTM B 308.

2.2.3 Uncoated Steel

2.2.3.1 AASTM A 570, ASTM A 606, or ASTM A 1011.

2.2.4 Galvanized Steel

2.2.4.1 ASTM A 653, G 90 coating designation, 0.045 inch minimum thickness.

2.2.5 Aluminum Sheet

2.2.5.1 Aluminum sheet shall conform to ASTM B 209, 0.032 inch minimum thickness. Aluminum structural shapes and tubes shall conform to ASTM B 221 or ASTM B 308. Structural pipe shall conform to ASTM A 53, ASTM A 252, ASTM A 500, ASTM A 501, ASTM A 618, ASTM B 221, ASTM B 241, or ASTM B 429. Holes for structural connections shall be made in the shop.

2.2.6 Structural Tube

2.2.6.1 ASTM A 500 or ASTM B 221.

2.3 ACCESSORIES

2.3.1 Caps, Strips, and Plates

2.3.1.1 Form ridge caps, eave and edge strips, fascia strips, miscellaneous flashings, and miscellaneous sheet metal accessories from the same material and gage as the roof panels. Wall plates, base angles or base channels, and other miscellaneous framing members may be standard structural steel shapes, or may be formed from steel not lighter than 18 gage thick.

2.3.2 Closure Strips

2.3.2.1 Provide closure strips of closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the covering. Closure strips shall not absorb or retain water.

2.3.3 Sealant

2.3.3.1 Provide elastomeric type sealant containing no oil or asphalt. Exposed sealant shall cure to a rubberlike consistency. Concealed sealant may be the nonhardening type.

2.3.4 Gaskets and Insulating Compounds

2.3.4.1 Provide nonabsorptive gaskets and insulating compounds suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.3.5 Fasteners

2.3.5.1 Provide fasteners for steel wall and roof panels of zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum wall and roof panels shall be aluminum or corrosion resisting steel. Fasteners for structural connections shall provide both tensile and shear strength of not less than 750 pounds per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be gasketed or have gasketed washers on the exterior side of the covering to waterproof the fastener penetration. Washer material shall be compatible with the covering; have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. When wall covering is factory color finished, exposed wall fasteners shall be color finished or provided with plastic color caps to match the covering. Nonpenetrating fastener system using concealed clips shall be manufacturer's standard for the system provided.

a. Screws

(1) Provide self-tapping screws not less than No. 14 diameter and not less than No. 12 diameter if self-drilling/self-tapping type.

b. End-Welded Studs

(1) Provide automatic shouldered type studs with a shank diameter of not less than 3/16 inch and cap or nut for holding covering against the shoulder.

c. Explosive Actuated Fasteners

(1) Fasteners for use with explosive actuated tools shall have a shank diameter of not less than 0.145 inch with a shank length of not less than 1/2 inch for fastening panels to steel and not

less than one inch for fastening panels to concrete.

d. Blind Rivets

(1) Provide aluminum rivets with 3/16 inch nominal diameter shank or stainless steel rivets with 1/8 inch nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Provide hollow stem rivets with closed ends.

e. Bolts

(1) Provide bolts not less than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.3.6 Gutters

2.3.6.1 Provide complete with mitered corners, end pieces, and special pieces that may be required. Expansion-type slip joints shall be provided at the center of the runs and at intervals of not more than 32 feet for aluminum and not more than 40 feet for steel. Provide water tight seal at all other joints. Provide gutters below the slope line of the roof, to allow snow and ice to slide clear. Provide hangers and fastenings from a metal compatible with the gutters. Space hangers not more than 36 inches apart.

2.3.7 Downspouts

2.3.7.1 Provide cross sectional area not less than the size of gutter indicated and complete including elbows and offsets. Provide downspouts in approximately 10 foot lengths; end joints shall telescope not less than 1/2 inch, and longitudinal joints shall be locked. Provide gutter outlets with stainless steel wire ball strainers of a standard type. Position downspouts not less than 1/2 inch away from walls and fasten to the walls at top, bottom, and at not to exceed 5 foot centers intermediately between with manufacturer's standard type leader straps, or concealed type fasteners. Form straps and fasteners from a metal compatible with the downspouts.

2.3.8 Circular Roof Ventilators

2.3.8.1 Provide circular roof ventilators fabricated of aluminum or zinc-coated steel with manufacturer's standard factory finish, color as indicated, furnished with removable insect screens and chain or cable operated dampers. Provide rigid weathertight ventilators free from vibration upon installation.

2.3.9 Continuous (Ridge) Roof Ventilators

2.3.9.1 Provide ventilators fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel, of manufacturer's standard factory finish, color as indicated, complete with braces, chain-operated dampers, and bird screening. Provide ventilators in sections 8 or 10 feet long, braced at midlength. Join sections together with splice plates of the same material as the sections. Provide end closures for each section.

2.3.10 Louvers

2.3.10.1 Provide louvers and frames of the sizes, design, and color indicated. Provide manufacturer's standard factory finish. Fold or bead blades at the edges, set at an angle to exclude driving rains, and secure to the frames by riveting or welding as standard with manufacturer. Provide mullions for louvers over 4 feet in width; provide not less than one mullion for each 4 foot width. Provide flanges on the interior face of frames where air intakes or exhaust louvers are

indicated to be connected with mechanically-operated dampers or metal ductwork. Provide woven wire bird screening, not less than 3 by 3 mesh per square inch in rewirable frames, on the interior exterior of louvers; install screen frames by means of clips to allow easy removal for cleaning and rewiring. The screens and frames shall be of the same type metal as the louvers; screen wire shall be not less than 0.0475 inch in diameter. Provide framing and flashings as necessary for installation of louvers.

2.3.11 Skylights

2.3.11.1 Skylights shall conform to the requirements of Section 08 62 00 Skylights.

2.3.12 Light Transmitting Roof Panels (Insulating)

2.3.12.1 Standard with the manufacturer of size indicated. The light transmitting roof panels shall consist of an interior and exterior plastic face with a sealed airspace of one to 1-1/2 inches. The exterior plastic face shall be not less than 0.055 inch thickness and shall have the same configurations as the roofing panels. The interior plastic face shall be not less than 0.035 inch thickness. Plastic faces shall be fiberglass consisting of polyester synthetic resin reinforced with a fibrous glass mat and rated self-extinguishing by Underwriters Laboratories. The "U" factor of the light transmitting roof panels shall not be more than 0.50.

2.3.13 Light Transmitting Roof Panels (Noninsulating)

2.3.13.1 ASTM D 3841, Type II, Grade 1, weighing not less than 8 ounces per square foot, standard with the manufacturer. Size and color as indicated. Provide light transmitting roof panels of the same configuration as the roof panel.

2.3.14 Plastic Wall Lights

2.3.14.1 ASTM D 3841, Type II, Grade 1, weighing not less than 8 ounces per square foot, standard with the manufacturer. Size and color as indicated. Provide wall lights of the same configuration as the metal wall panels.

2.3.15 Insulation

2.3.15.1 Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Blanket insulation shall have a facing as specified in paragraph VAPOR RETARDER. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory. Contractor shall comply with EPA requirements in accordance with Section 01 62 35 Recycled / Recovered Materials.

a. Rigid Board Insulation

(1) Polyisocyanurate: Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2 (having a recovered material content in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil) the maximum design R-value per 1 inch of insulation used shall be 7.2 inch.

(2) Polystyrene: Insulation shall conform to ASTM C 578, Type IV.

b. Mineral Fiber

(1) Insulation shall conform to ASTM C 612.

c. Blanket Insulation

(1) Blanket insulation shall conform to ASTM C 991 0.6 pound fiber-glass as standard with the metal building manufacturer having a factory-applied facing on one side and a permeance rating of 0.05 or less when tested in accordance with ASTM E 96.

(a) Facing on insulation shall be vinyl-scrim foil, except that behind liner panels, facing may be 0.002 inch thick aluminum foil. Vinyl-scrim foil shall have a tensile strength of not less than 40 pounds machine direction and 30 pounds cross machine direction when tested in accordance with ASTM D 828.

(b) The insulation, including facings, shall have a flame spread rating of 75 or less and a smoke development factor of 150 or less when tested in accordance with ASTM E 84.

(c) Wall insulation shall have guarded hot box values for "R" as indicated, measured in accordance with ASTM C 1363 test method. Roof insulation shall have guarded hot box values for "R" as indicated, measured in accordance with ASTM C 1363.

(d) Provide insulation containing 20 percent or greater recovered material which has been diverted from solid waste, but not including material reused in a manufacturing process. Where two materials have the same price and performance, provide the one containing the higher recovered material content.

d. Insulation Retainers

(1) Retainers shall be type, size and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.3.16 Vapor Retarder

2.3.16.1 Vapor Retarders as Integral Facing

a. Insulation facing shall have a permeability of 0.02 perm or less when tested in accordance with ASTM E 96. Facing shall be white reinforced polypropylene kraft laminate (PSK). Facings and finishes shall be factory applied.

2.3.16.2 Vapor Retarders Separate from Insulation

a. Vapor retarder material shall be polyethylene sheeting conforming to the requirements of ASTM D 4397. A single ply of 10 mil polyethylene sheet; or, at the option of the Contractor, a double ply of 6 mil polyethylene sheet shall be used. A fully compatible polyethylene tape shall be provided which has equal or better water vapor control characteristics than the vapor retarder material. A cloth industrial duct tape in a utility grade shall also be provided to use as needed to protect the vapor retarder from puncturing.

2.3.17 Doors and Windows

2.3.17.1 Provide framing members and flashings as necessary for installation of the doors and windows.

a. Swinging Personnel Doors and Frames

(1) SDI/DOOR A250.8, Grade II, Model 1, 2, 3, or 4, design as indicated, zinc-coated and shop

primed, exterior mounting. Doors shall be glazed where indicated. Hardware shall conform to BHMA A156.1, BHMA A156.2, BHMA A156.3, and BHMA A156.4. Doors shall be provided with hardware as shown on the drawings.

b. Sliding Doors

(1) Hollow metal type shall conform to SDI/DOOR A250.8, Grade II, Model 1, 2, 3, or 4, design as indicated, zinc-coated and shop primed. Sheet metal type shall consist of steel framework covered with siding of the same type and finish as used for the building. Provide hardware necessary for the complete installation of sliding doors. Sliding door hardware shall include heavy-duty zinc-coated steel tracks, brackets, end and center stops, not less than two-wheel ball or roller bearing, adjustable type hangers - two per leaf, binders, guides, handles, heavy type cane bolt and socket for one leaf of pairs of doors, padlock eyes or heavy safety hasp, and flashing for outside door tracks. Hardware items shall be approved types, standard with the door manufacturer.

c. Overhead Doors Rolling Doors

(1) Overhead rolling doors shall conform to the requirements of Section 08 33 23 Overhead Rolling Doors_____. Hardware shall be as scheduled on the drawings.

d. Sectional Overhead Doors

(1) Sectional overhead doors shall conform to the requirements of Section 08 36 13 Sectional Overhead Doors. Hardware shall be as scheduled on the drawings.

e. Vertical Lift Doors

(1) Vertical lift doors shall conform to the requirements of Section 08 36 19 Vertical Lift Doors. Hardware shall be as scheduled on the drawings.

f. Aluminum Windows

(1) Aluminum Windows: AAMA 101, Type as indicated. Windows shall be factory glazed with insulated glass. Provide aluminum with manufacturer's standard factory finish, color as indicated. Ventilating sections shall be provided with insect screens. Windows shall be provided with thermal barrier features.

2.3.18 Canopies

2.3.18.1 Of same materials and finish as the building. Soffit materials shall be of material indicated.

2.3.19 Sealant

2.3.19.1 Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubber like consistency.

2.3.20 Gaskets and Insulating Compounds

2.3.20.1 Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.4 FINISH

2.4.1 Shop Painting

2.4.1.1 Ferrous metal work, except factory-finished work, zinc-coated work, aluminum-coated work,

and work specified to be painted herein, shall be (1) cleaned of dirt, rust, scale, loose particles, grease, oil, and other deleterious substances; (2) phosphate treated; and (3) then be given one coat of an approved rust-inhibiting primer paint of the type standard with the metal building manufacturer.

2.4.2 Factory Color Finish

2.4.2.1 Provide exterior and interior exposed surfaces of metal roof and wall panels, roof ventilators, louvers, gutters, downspouts, and metal accessories with a thermal-cured factory finish. Color shall be selected from manufacturer's standard colors. Provide an exterior finish top coat of 50 percent resin silicone polyester or 70 percent resin fluoropolymer. Provide standard dry film thickness of 0.8 mil for exterior coating exclusive of primer. Provide exterior primer thickness standard with building manufacturer 0.2 0.8 mil. Interior color finish shall consist of a backer coat with dry film thickness of 0.5 mil thick prime coat. Provide exterior color finish meeting the test requirements specified below. Tests shall have been performed on the same factory finish and thickness provided.

2.4.3 Testing of Factory Color Finishes

2.4.3.1 Salt Spray Test

a. A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610 and a rating of 6, over 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.4.3.2 Accelerated Weathering Test

a. ASTM G 23, Method 2, Type D apparatus minimum 2000 hours or Type EH apparatus minimum 500 hours, no checking, blistering or loss of adhesion; color change less than 5 NBS units by ASTM D 2224 and chalking less than No. 8 rating by ASTM D 4214.

2.4.3.3 Flexibility

a. ASTM D 522, Method A, 1/8 inch diameter, 180 degree bend, no evidence of fracturing to the naked eye.

2.4.3.4 Adhesion

a. ASTM D 3359, Method B, for laboratory test and film thickness less than 5 mil and Method A for site tests. There shall be no film removed by tape applied to 11 parallel cuts spaced 1/8 inch apart plus 11 similar cuts at right angles.

2.4.3.5 Impact

a. ASTM D 2794, no loss of adhesion after direct and reverse impact equal to 1.5 times metal thickness in mils, expressed in inch-pounds.

2.4.3.6 Humidity Resistance

a. ASTM D 2247, 1000 hours, no signs of blistering, cracking, creepage or corrosion on score panel.

2.4.3.7 Specular Gloss

a. ASTM D 523, finished surfaces exposed to the building exterior shall have a specular gloss of 10 measured at an angle of 85 degrees.

2.4.3.8 Formability Test

a. When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.4.3.9 Pollution Resistance

a. Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

PART 3 EXECUTION

3.1 INSPECTION

3.1.1 Check concrete dimensions, anchor bolt size and placement, and slab elevation with the metal building manufacturer's templates and drawings before setting any steel.

3.2 ERECTION

3.2.1 Erect in accordance with the manufacturer's approved erection instructions and diagrams. Correct defects and errors in the fabrication of building components in a manner approved by the Contracting Officer. If defects or errors in fabrication of components cannot be corrected, remove and provide nondefective components. When installing wall and roof systems, install closure strips, flashing, sealing material, and other accessories in accordance with building manufacturer's instructions to provide a weathertight system, free of abrasions, loose fasteners, and deformations. After erection is complete, repair and coat abraded and damaged, primed or factory-finished surfaces to match adjacent surfaces.

3.2.1.1 Dissimilar Materials

a. Prevent direct contact between aluminum surfaces, and ferrous or other incompatible metals, by one of the following methods:

(1) Paint the incompatible metal with a coating of manufacturer's standard heavy-bodied paint.

(2) Paint the incompatible metal with a prime coat of corrosion inhibitive primer followed by one or two coats of aluminum metal-and-masonry paint, or other suitable protective coating, excluding products containing lead and chromium pigmentation.

(3) Provide an approved nonabsorptive gasket.

(4) Apply an approved calking between the aluminum and the incompatible metal.

b. If drainage from incompatible metal passes over aluminum, paint the incompatible metal by method (a) or (b). Paint aluminum surfaces in contact with concrete or masonry materials by method (a). Paint green or wet wood, or wood treated with incompatible wood preservatives, by method (a) or use two coats of aluminum paint.

3.2.1.2 Rigid Frames, Bases, and Sill Members

a. Brace frames as necessary to ensure safety. Set accurately, using a nonshrink grout to obtain uniform bearing on the concrete and to maintain a level base line elevation. Separate leveling

plates under column base plates shall not be used. Members shall be accurately spaced to assure proper fitting of panels. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses. Supports for electric overhead traveling cranes shall be positioned and aligned in accordance with CMAA 70. Clean surfaces to receive the mortar and thoroughly moisten immediately before placement of mortar. Water cure exposed surfaces of mortar with wet burlap for 7 days.

(1) Field Welding

(a) Steel, AWS D1.1. Aluminum, AA 30.

(2) Field Bolting

(a) AISC S329. Improper or mislocated bolt holes in structural members or other misfits caused by improper fabrication or erection, shall be repaired in accordance with AISC 303. Concrete work is specified in 03 30 00 Cast-In-Place Concrete. Anchor bolts shall be accurately set by template while the concrete is in a plastic state.

3.2.1.3 Wall Construction

a. Apply panels full wall heights from base to eave with no horizontal joints except at the junctions of door frames, window frames, louver panels, and similar locations. Lay side laps away from the prevailing winds. Seal side and end laps with the joint sealing material recommended by the manufacturer. Flash or seal walls at the base, at the top, around windows, door frames, framed louvers, and other similar openings. Flashing will not be required where approved "self-flashing" panels are used. Minimum end laps for all types of panels shall be 2-1/2 inches. Minimum side laps for all types of panels shall be one corrugation, one configuration, or an interlocking joint. Install liner panels to height indicated above finished floor.

3.2.1.4 Roof Construction

a. Apply the roofing panels in full lengths from ridge to eaves with no transverse joints except at the junction of ventilators, curbs, light transmitting roof panels, chimneys, and similar openings. Lay side laps away from the prevailing wind, and seal side and end laps with joint sealing material. Flash and seal the roof at the ridge, at eaves and rakes, at projections through the roof, and elsewhere as necessary. Minimum side lap shall be one corrugation, configuration, or interlocking rib except 1-1/2 corrugations for standard corrugated sheets.

3.2.1.5 Installation of Gutters and Downspouts

a. Gutters and downspouts shall be rigidly attached to the building. Spacing of cleats for gutters shall be 16 inches maximum. Spacing of brackets and spacers for gutters shall be 36 inches maximum. Supports for downspouts shall be spaced according to manufacturer's recommendations.

3.2.1.6 Louvers and Ventilators

a. Louvers and ventilators shall be rigidly attached to the supporting construction to assure a weather tight installation.

3.2.1.7 Doors and Windows

a. Doors and windows, including frames and hardware, shall be securely anchored to the supporting construction, shall be installed plumb and true, and shall be adjusted as necessary to provide proper operation. Joints at doors and windows shall be sealed according to manufacturer's recommendations to provide weathertight construction.

3.2.1.8 Minimum Fastener Spacing

a. Space fasteners according to manufacturer's instructions, but not to exceed:

(1) 8 inches o.c. at end laps of covering,

(2) 12 inches o.c. at connection of covering to intermediate supports,

(3) 12 inches o.c. side laps of roof coverings, 18 inches o.c. at side laps of wall.

3.2.1.9 Installation of Insulation

a. Roof Insulation

(1) Install over purlins before roof coverings are applied. Hold insulation rigid until secured in place. Insulation facing shall be exposed on the interior side of the building. Fold and staple facing tabs of insulation on 6 inch centers, from exterior side of building to completely seal joints. If folding and stapling can only be accomplished from the inside, push the tabs neatly up between the edges of adjoining blankets , and cover side laps of insulation with metal strips formed for this purpose and paint to match the facing material. Install the strips spanning from purlin to purlin and in accordance with the metal building manufacturer's recommendations.

b. Wall Insulation

(1) Install over girts before wall coverings are applied. Hold insulation rigid until secured in place. Expose facing toward the interior side of the building. Fold and staple facing tabs of insulation on 6 inch centers, from exterior side of building, to completely seal joints. If folding and stapling can only be accomplished from the inside, push the tabs neatly up between the edges of adjoining blankets , and cover side laps of insulation with metal strips formed for this purpose and paint to match the facing material. Install the strips spanning from girt to girt and in accordance with the metal building manufacturer's recommendations.

3.2.1.10 Vapor Retarder Installation

a. Integral Facing on Blanket Insulation

(1) Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

b. Polyethylene Vapor Retarder

(1) The polyethylene vapor retarder membrane shall be installed over the entire surface. A fully compatible polyethylene tape shall be used to seal the edges of the sheets to provide a vapor tight membrane. Sheet edges shall be lapped not less than 6 inches. Sufficient material shall be provided to avoid inducing stresses in the sheets due to stretching or binding. All tears or punctures that are visible in the finished surface at any time during the construction process shall be sealed with polyethylene tape.

3.2.1.11 Wall Liner

a. Wall liner shall be securely fastened into place in accordance with the manufacturer's recommendation and in a manner to present a neat appearance.

3.3 FIELD PAINTING

3.3.1 Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire

brushed and touched up with the same color and material used for the shop coat. Section 09 90 00 Paints & Coatings, for painting of shop-primed ferrous surfaces exposed on the outside of the building and all shop-primed surfaces of doors and windows.

3.4 FIELD QUALITY CONTROL

3.4.1 At the discretion of the Contracting Officer, sample panels may be taken at random from each delivery or from stockpiles on the site at any time during the construction period, and tests may be made to check the conformance of the materials to the requirements specified in paragraph entitled "Factory Color Finish." Failure of the sample sheets to pass the required tests shall be cause for rejection of all sheets represented by the samples and replacement of the entire shipment.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR
PREENGINEERED METAL BUILDINGS

FACILITY
DESCRIPTION:_____

BUILDING
NUMBER:_____

CONTRACTOR

CONTRACTOR:_____
ADDRESS:_____

POINT OF
CONTACT:_____

TELEPHONE
NUMBER:_____

OWNER

OWNER:_____

ADDRESS:_____

POINT OF
CONTACT:_____

TELEPHONE
NUMBER:_____

CONSTRUCTION AGENT

CONSTRUCTION
AGENT:_____
ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE
NUMBER:_____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR
PREENGINEERED METAL BUILDINGS

THE METAL BUILDING SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE AND STRUCTURAL FAILURE WITHIN PROJECT SPECIFIED DESIGN LOADS, AND LEAKAGE. THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: FRAMING AND STRUCTURAL MEMBERS, ROOFING AND SIDING PANELS AND SEAMS, INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS, ACCESSORIES, TRIM, FLASHINGS AND MISCELLANEOUS BUILDING CLOSURE ITEMS SUCH AS DOORS AND WINDOWS (WHEN FURNISHED BY THE MANUFACTURER), CONNECTORS, COMPONENTS, AND FASTENERS, AND OTHER SYSTEM COMPONENTS AND ASSEMBLIES INSTALLED TO PROVIDE A WEATHERTIGHT SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THESE SPECIFICATIONS THAT BECOME PART OF THE METAL BUILDING SYSTEM. ALL MATERIAL AND WORKMANSHIP DEFICIENCIES, SYSTEM DETERIORATION CAUSED BY EXPOSURE TO THE ELEMENTS AND/OR INADEQUATE RESISTANCE TO SPECIFIED SERVICE DESIGN LOADS, WATER LEAKS AND WIND UPLIFT DAMAGE SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON _____ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

_____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR
PREENGINEERED METAL BUILDINGS
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE METAL BUILDING SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE BUILDING SYSTEM DUE TO ACTIONS BY THE OWNER WHICH INHIBIT FREE DRAINAGE FROM THE ROOF, AND GUTTERS AND DOWNSPOUTS; OR CONDITIONS WHICH CREATE PONDING WATER ON THE ROOF OR AGAINST THE BUILDING SIDING.

6. THIS WARRANTY APPLIES TO THE METAL BUILDING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES. REPORTS OF LEAKS AND BUILDING SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR
PREENGINEERED METAL BUILDINGS
(Exclusions from Coverage Continued)

IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE METAL BUILDING SYSTEM REPLACED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR. IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION, UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED THE PARTIES SHALL, WITHIN 10 DAYS JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN 10 DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT. A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

*** END OF SECTION ***

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(2011) Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies - (ANSI approved 2010)

ASME INTERNATIONAL (ASME)

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A135/A135M	(2009; R2014) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A183	(2014) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2015a) Standard Specification for Alloy-Steel and Stainless Steel Bolting

	Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A449	(2014) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A795/A795M	(2013) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B62	(2015) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2011; Errata 2013) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2015; ERTA 2015) Life Safety Code
NFPA 13	(2013; TIA 10-1; TIA 11-2; ERTA 2014; TIA 14-3) Standard for the Installation of Sprinkler Systems
NFPA 1963	(2014) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2010) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2013) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 668	(2004; Reprint Dec 2012) Hose Valves for Fire-Protection Service
UL Bld Mat Dir	(2012) Building Materials Directory
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage. Provide wet pipe sprinkler system in areas indicated on the drawings. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Rack sprinklers shall be in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. Design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

1.2.1 Hydraulic Design

Hydraulically design the system to discharge a minimum density of 0.2 gpm/square foot over the hydraulically most demanding 3250 square feet of floor area. The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

1.2.1.1 Hose Demand

Add an allowance for exterior hose streams of 250 gpm to the sprinkler system demand at the point of connection to the existing system.

1.2.1.2 Basis for Calculations

The fire sprinkler contractor shall perform a new flow test at the building site. The basis of design of the system shall be based upon a water supply

with a static pressure of 60, and a flow of 530 at a residual pressure of 60. Water supply shall be presumed available at the point of connection to existing. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping.

1.2.1.3 Hydraulic Calculations

Submit hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments and as outlined in NFPA 13, except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable.Calculations shall be based on the water supply data shown on the drawings to substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

1.2.2 Sprinkler Coverage

Sprinklers shall be uniformly spaced on branch lines. In buildings protected by automatic sprinklers, sprinklers shall provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms, boiler rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13, but shall not exceed 100 square feet for extra hazard occupancies, 130 square feet for ordinary hazard occupancies, and 225 square feet for light hazard occupancies. Exceptions are as follows:

a. Facilities that are designed in accordance with NFPA 13R and NFPA 13D.

b. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G As-
Built Drawings

SD-03 Product Data

Fire Protection Related Submittals
Materials and Equipment; G
Spare Parts
Preliminary Tests; G
Final Acceptance Test; G
Onsite Training; G
Fire Protection Specialist; G
Sprinkler System Installer; G

SD-05 Design Data

Sway Bracing; G
Hydraulic Calculations; G

SD-06 Test Reports

Preliminary Test Report
Final Acceptance Test Report

SD-07 Certificates

Inspection by Fire Protection Specialist

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G

1.4 QUALITY ASSURANCE

Compliance with referenced NFPA standards is mandatory. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governS. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

1.4.1 Fire Protection Specialist

Perform work specified in this section under the supervision of and certified by the Fire Protection Specialist who is an individual registered professional engineer who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES) or who is certified as a Level III Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. Submit the name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations. The Fire Protection Specialist shall prepare and submit a list of the fire protection related submittals, no later than 7 days after the approval of the Fire Protection Specialist, from the Contract Submittal

Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.2 Sprinkler System Installer

Work specified in this section shall be performed by the Sprinkler System Installer who is regularly engaged in the installation of the type and complexity of system specified in the contract documents, and who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months. Submit the name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

1.4.3 Shop Drawings

Shop Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Submit 3 copies of the Sprinkler System shop drawings, no later than 21 days prior to the start of sprinkler system installation. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. Submit load calculations for sizing of sway bracing, for systems that are required to be protected against damage from earthquakes.

1.5 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Provide Materials and Equipment that have been tested by Underwriters Laboratories, Inc. and are listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM APP GUIDE. Submit manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, provide a complete equipment list that includes equipment description, model number and quantity.

2.4 ABOVEGROUND PIPING COMPONENTS

Aboveground piping shall be steel .

2.4.1 Steel Piping Components

2.4.1.1 Steel Pipe

2.4.1.1.1 Steel Pipe (Wet Pipe Systems)

A. All pipe shall be coated black steel pipe as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795/A 795M, ASTM A 53/A 53M, or ASTM A 135/A 135M. All pipe and fittings shall be listed by Underwriters'

Laboratories, Inc. and Factory Mutual Insurance Company tested and approved. All pipe and fittings shall be marked with the name of the manufacturer, pipe Schedule, and ASTM/UL/FM designations. All piping materials stored at the site shall be supported off the ground with the ends protected to prevent dirt or debris from entering the pipe.

B. Concealed Spaces - All wet pipe fire suppression system piping located in concealed spaces such as furred ceilings, wall cavities, pipe chases, and under floor spaces shall be Schedule 40 black steel with welded or threaded joints. Cut groove mechanical joints may be used in concealed spaces where indicated on the drawings if access doors are provided for inspection of the joints in accordance with the NFPA. All tees shall be welded groove-o-let fittings.

C. Non-Concealed Spaces (Piping 2 inch diameter and smaller) - All wet pipe fire suppression system pipe 2 inches in diameter and smaller exposed to view or accessible above lay-in ceilings shall be Schedule 40 black steel with welded or cut groove mechanical joints. All tees shall be welded groove-o-let fittings. Screw threaded pipe joints are permissible only for installation of sprinkler heads, automatic air vents, drain line valves, or test fittings.

D. Non-Concealed Spaces (Piping 2 1/2 inch diameter and larger) - All wet pipe fire suppression system pipe 2 1/2 inches in diameter and larger exposed to view or accessible above lay-in ceilings shall be either Schedule 40 or Schedule 10 black steel. Joints shall be welded, cut groove (Schedule 40), or roll groove (Schedule 10) mechanical joints. All tees shall be welded groove-o-let fittings. Screw threaded fittings are permissible only for installation of sprinkler heads, automatic air vents, drain line valves, or test fittings.

E. All Schedule 40 and Schedule 10 pipe shall be internally factory coated with a UL and FM Listed thermosetting resin and a thermoplastic polyethylene, polypropylene, polybutylene material or UL/FM Listed equivalent coating incorporating an antimicrobial agent such as chlorinated phenol applied by electrostatic, fluidized bed, or flame spraying technique to help prevent biofilm formation and electrochemical reactions. Only saw cutting (no abrasive cutting) of the pipe shall be permitted to minimize damage to the pipe coatings.

F. Hydrostatically test the complete wet pipe system for 24 hours at the pressure recommended by the NFPA prior to concealing any portion of the system. The system shall be completely filled with water. Entrapped air shall be vented at each upright mounted sprinkler head and at each high point in the system. The hydrostatic test shall be witnessed by the contractor Fire Protection Specialist and a government official designated by the contracting officer.

G. The piping system shall be provided with a UL Listed automatic air vent fitting at each high point in the system and where otherwise indicated to remove entrapped air.

H. Provide proper slope in the system piping to drain the system; and provide an inspector test and drain fitting with pressure gage at each drain location.

I. Provide a flushing fitting at the end of each distribution main in gridded and looped system; and also at the end of each branch line in looped systems as allowable by NFPA. Gridded sprinkler systems are defined as having parallel cross mains connected by multiple branch lines so that an operating

sprinkler will receive water from both ends. Looped sprinkler systems are partial gridded systems where not all branch lines are not interconnected. Flushing fittings shall consist of a full size, full port ball valve with a fire department hose connection and a cap.

J. Disinfect the complete piping system with a concentrated hypochloride solution in accordance with this specification section to kill the anerobic and aerobic bacteria that may cause microbiologically induced corrosion (MIC). Backflush the entire wet pipe sprinkler system main and branch lines; fill with clean water; and vent all entrapped air at each upright sprinkler head and at each high point in the system.

2.4.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.4.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer;segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A183 and shall be cadmium plated or zinc electroplated.

2.4.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

2.4.1.5 Bolts, Nut, and Washers

Bolts shall be conform to ASTM A449, Type 1 and shall extend no less than three full threads beyond the nut with bolts tightened to the required torque. Nuts shall be hexagon type conforming to ASME B18.2.2 . Washers shall meet the requirements of ASTM F436. Flat circular washers shall be provided under all bolt heads and nuts.

2.4.2 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM APP GUIDE and of the type suitable for the application, construction, and pipe type and sized to be supported.

2.4.3 Valves

2.4.3.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside

stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM APP GUIDE.

2.4.3.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM APP GUIDE. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.5 ALARM CHECK VALVE ASSEMBLY

Assembly shall include a riser check valve, standard trim piping, pressure gauges, testing valves, main drain, and other components as required for a fully operational system.

2.6 WATERFLOW ALARM

Electrically operated, exterior-mounted, waterflow alarm bell shall be provided and installed in accordance with NFPA 13. Waterflow alarm bell shall be rated 24 VDC and shall be connected to the Fire Alarm Control Panel(FACP) in accordance with Section SECTION 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM

2.7 ALARM INITIATING AND SUPERVISORY DEVICES

2.7.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 10 gpm or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

2.7.2 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.8 FIRE DEPARTMENT CONNECTION

Fire department connection shall be projecting type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a polished brass finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.9 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Temperature classification shall be as indicated. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Extended coverage sprinklers shall not be used.

2.9.1 Concealed Sprinkler

Concealed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.2 Recessed Sprinkler

Recessed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.3 Flush Sprinkler

Flush sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.4 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, recessed quick-response type with nominal 1/2 inchor 17/32 inch orifice. Pendent sprinklers shall have a polished chrome finish.

2.9.5 Upright Sprinkler

Upright sprinkler shall be brass quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.6 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.

2.9.7 Corrosion Resistant Sprinkler

Corrosion resistant sprinkler shall be the upright pendent type installed in locations as indicated. Corrosion resistant coatings shall be factory-applied by the sprinkler manufacturer.

2.9.8 Dry Sprinkler Assembly

Dry sprinkler assembly shall be of the pendent, upright, sidewall, type as indicated. Assembly shall include an integral escutcheon. Maximum length shall not exceed maximum indicated in UL Fire Prot Dir. Sprinklers shall have a polished chrome finish.

2.10 ACCESSORIES

2.10.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

2.10.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

2.10.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

2.10.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located as required by NFPA-13..

2.10.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.11 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 175 psi The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of

NFPA 13, NFPA 24 and publications referenced therein. Installation of in-rack sprinklers shall comply with applicable provisions of NFPA 13.

3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

Prior to ceiling installation and concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports. The Fire Protection Specialist shall: 1) inspect the sprinkler system periodically during the installation to assure that the sprinkler system is being provided and installed in accordance with the contract requirements, 2) witness the preliminary and final tests, and sign the test results, 3) after completion of the system inspections and a successful final test, certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.4 ABOVEGROUND PIPING INSTALLATION

3.4.1 Protection of Piping Against Earthquake Damage

Seismically protect the system piping against damage from earthquakes. This requirement is not subject to determination under NFPA 13. Install the seismic protection of the system piping in accordance with UFC 3-310-04, NFPA 13 and Annex A. Include the required features identified therein that are applicable to the specific piping system.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

3.4.4 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches for steel pipe or 6 inches for copper tubing. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 1 inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed

the manufacturer's listed range and shall be of uniform depth throughout the finished area. Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid.

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.4.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools shall be products of the same manufacturer. For copper tubing, pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.4.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.4.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves.Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07 84 00 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but

pliable mass or with a mechanically adjustable segmented elastomer seal.

3.4.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected at the riser as a combination test and drain valve; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

3.4.11 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13.

3.4.12 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

3.4.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.5 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. SECTION 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM Wiring color code shall remain uniform throughout the system.

3.6 PIPE COLOR CODE MARKING

Color code mark piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.7 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Submit proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests and proposed date and time to begin the preliminary tests. The underground and aboveground interior piping systems and attached

appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, submit 3 copies of the completed Preliminary Test Report, no later than 7 days after the completion of the Tests. The Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

3.7.1 Aboveground Piping

3.7.1.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 24 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.7.1.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. Provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, pitot tube gauge, plus all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. Provide a metal placard on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

3.7.2 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

3.7.3 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.8 FINAL ACCEPTANCE TEST

Begin the Final Acceptance Test only when the Preliminary Test Report has been approved.Submit proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests, and proposed date and time to begin the Test, submitted with the procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's

Material & Test Certificates. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. Submit as-built shop drawings, at least 14 days after completion of the Final Tests, updated to reflect as-built conditions after all related work is completed. Drawings shall be on reproducible full-size mylar film. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. Submit 3 copies of the completed Final Acceptance Test Report no later than 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.as specified.

3.9 ONSITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit proposed schedule, at least 14 days prior to the start of related training. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete and after the Final Acceptance Test. Submit 6 Operating and Maintenance Manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. The Onsite Training shall cover all of the items contained in the approved manuals.

-- End of Section --

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE
11/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2011) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2008) Performance Requirements for Atmospheric Type Vacuum Breakers (ANSI approved 2009)
ASSE 1010	(2004) Performance Requirements for Water Hammer Arresters (ANSI approved 2004)
ASSE 1011	(2004; Errata 2004) Performance Requirements for Hose Connection Vacuum Breakers (ANSI approved 2004)
ASSE 1012	(2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)
ASSE 1013	(2011) Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers - (ANSI approved 2010)
ASSE 1018	(2001) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002
ASSE 1019	(2011) Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type (ANSI Approved 2004)

ASSE 1020	(2004; Errata 2004; Errata 2004) Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI Approved 2004)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA C606	(2015) Grooved and Shouldered Joints
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C652	(2011) Disinfection of Water-Storage Facilities
AWWA C700	(2015) Standard for Cold Water Meters - Displacement Type, Bronze Main Case

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2010) Specification for Brazing Procedure and Performance Qualification

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(2012) Standard for Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.36.2M	(1991; R 2012) Cleanouts
ASME A112.6.1M	(1997; R 2012) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2001; R 2007) Standard for Floor and Trench Drains
ASME B1.20.1	(2013) Pipe Threads, General Purpose (Inch)
ASME B16.15	(2013) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2011) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(2011) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500

ASME B16.29	(2012) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2013) Valves - Flanged, Threaded and Welding End
ASME B16.50	(2013) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B31.1	(2014; INT 1-47) Power Piping
ASME B31.5	(2013) Refrigeration Piping and Heat Transfer Components
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A183	(2014) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A74	(2013a) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A888	(2013a) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B306	(2013) Standard Specification for Copper Drainage Tube (DWV)
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B42	(2015a) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2014) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B813	(2010) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B828	(2002; R 2010) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM B88	(2014) Standard Specification for Seamless Copper Water Tube

ASTM B88M	(2013) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C564	(2014) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2665	(2014) Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2822/D2822M	(2005; E 2011; R 2011) Asphalt Roof Cement
ASTM D2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F1760	(2001; R 2011) Coextruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F2389	(2010) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F891	(2010) Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2009) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2011) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2010) Copper Tube Handbook

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2009) Accessible and Usable Buildings and Facilities
ICC IPC	(2012) International Plumbing Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2011; Errata 2013) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 372	(2011) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2014) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2015) Drinking Water System Components - Health Effects

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2009) Hose Clamp Specifications

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 141.80	National Primary Drinking Water Regulations; Control of Lead and Copper; General Requirements
PL 109-58	Energy Policy Act of 2005 (EPAct05)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.2.1 Shop Drawings

Plumbing System; G

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

1.2.2 Product Data

All plumbing fixtures as scheduled in the drawings.

List of installed fixtures with manufacturer, model, and flow rate.

Flush Valve Water Closets

Flush Valve Urinals

Wall Hung Lavatories

Kitchen Sinks

Service Sinks

Drinking-Water Coolers; G

Backflow Prevention Assemblies; G

Welding

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features; G

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

Plumbing System

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

1.2.3 Test Reports

Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Test of Backflow Prevention Assemblies; G

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

1.2.4 Certificates

Materials and Equipment

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

1.2.5 Operation and Maintenance Data

Plumbing System; G

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in

satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1 – IP.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.2 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. PVC pipe shall contain a minimum of 25 percent recycled content in accordance with ASTM F1760. Steel pipe shall contain a minimum of 25 percent recycled content, with a minimum of 16 percent post-consumer recycled content. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Iron Pipe size and shall comply with NSF/ANSI 14, NSF/ANSI 61 and ASTM F2389. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61, Annex G or NSF 372. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums.

2.2.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used underground. Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310.
b. Coupling for Steel Pipe: AWWA C606.

c. Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.

d. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

e. Solder Material: Solder metal shall conform to ASTM B32.

f. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.

g. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

h. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

i. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

j. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.

k. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.

l. Copper tubing shall conform to ASTM B88M (ASTM B88), Type L.

2.2.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D2822/D2822M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

2.2.3 Pipe Insulation Material

Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.3 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58.

2.4 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Trap Seal Primer Valves	ASSE 1018

2.4.2 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.4.3 Wall Hydrants (Frostproof)

ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.5 FIXTURES

Fixtures shall be water conservation type, in accordance with ASHRAE 189.1 Section 6.3.2.1 (Plumbing fixtures and Fittings). Water closet replacements in major renovations may have a flush valve of up to 1.6 GPF to accommodate existing plumbing capacity. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Internal parts of flush valves and pop-up stoppers of lavatory waste drains shall be copper alloy with all visible surfaces chrome plated.

2.6 BACKFLOW PREVENTERS

Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies.

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be meet the above requirements.

Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.7 DRAINS

2.7.1 Floor Drains

Floor drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping

device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.6.3.

2.9 TRAPS

Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.16 DOMESTIC WATER SERVICE METER

Cold water meters 2 inches and smaller shall be positive displacement type conforming to AWWA C700. Meter register may be round or straight reading type. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

Provide water meters to monitor use in building consuming indoor and outdoor water as required by DODI 4170.11 (Installation Energy Management).

Meters must be connected to the base wide energy and utility monitoring and control system using the installation's advanced metering protocols.

2.19 MISCELLANEOUS PIPING ITEMS

2.19.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.19.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where [supply] drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

2.19.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.19.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet.

2.19.3 Pipe Hangers (Supports)

Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A gate valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines. Sewer and water pipes shall be laid in separate trenches. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.3.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2 1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3.5 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.6 Copper Tube and Pipe

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 50 mm (2 inches) and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.

3.1.3.7 Plastic Pipe

PVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3.11 Other Joint Methods

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.6.1 Sleeve Requirements
Unless indicated otherwise, provide pipe sleeves meeting the following requirements:
Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

Unless otherwise indicated, sleeves shall be of a size to provide a minimum of one inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.1.6.2 Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.6.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS and WATERPROOFING, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.6.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.7 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.8 Supports

3.1.8.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.8.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-58 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC pipe shall be 120 degrees F for PVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

l. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.8.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3.1.10 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.5 Fixture Supports

Fixture supports for off-the-floor urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.5.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.6 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

3.3.9 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type.

3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.6.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable

components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

Color	System	Item	Location
[_____]	[_____]	[_____]	[_____]

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.1 Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.8.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.8.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

3.9 TESTS, FLUSHING AND DISINFECTION

3.9.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC , except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure and reasons for choosing this option in lieu of the smoke test to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.9.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name

Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

3.9.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

3.9.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1 - IP for minimum efficiency requirements. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 141.80 (c) (1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

J . Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.9.5 Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer.

Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.12 TABLES

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X		
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X		
3	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X		
4	Seamless red brass pipe, ASTM B43				X		

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F
5	Cast bronze threaded fittings, ASME B16.15				X		
6	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X		
7	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X		
8	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X		
9	Cast bronze threaded fittings, ASME B16.15				X		
10	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D2665, ASTM F891, (Sch 40) ASTM F1760	X	X	X	X		

SERVICE:
A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
1	Seamless red brass pipe, ASTM B43	X	X		

2	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X		
3	Seamless copper pipe, ASTM B42	X	X		
4	Seamless copper water tube, ASTM B88, ASTM B88M	X**	X**		
5	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		
6	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5, 7 and 8	X	X		
7	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Item 8	X	X		
8	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B828	X	X		
	SERVICE: A - Cold Water Service Aboveground B - Hot and Cold Water Distribution 82 degrees C 180 degrees F Maximum Aboveground C - Compressed Air Lubricated D - Cold Water Service Belowground Indicated types are minimum wall thicknesses. ** - Type L - Hard *** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors **** - In or under slab floors only brazed joints				

-- End of Section --

SECTION 23 00 00

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2012) Laboratory Methods of Testing Dampers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 260 I-P	(2012) Sound Rating of Ducted Air Moving and Conditioning Equipment
AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2012; Errata 2013; INT 1 2014; ADD A, B, AND D SUPP 2015; INT 3 2015; Errata 2 2015; ADD C 2015) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2010) Ventilation for Acceptable Indoor Air Quality

ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct
ASHRAE 70	(2006; R 2011) Method of Testing for Rating the Performance of Air Outlets and Inlets
ASHRAE 90.1 - IP	(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A924/A924M	(2014) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280	(2013) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B766	(1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C1071	(2012) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM C553	(2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2014) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM D1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D3359	(2009; E 2010; R 2010) Measuring Adhesion by Tape Test
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E2016	(2011) Standard Specification for Industrial Woven Wire Cloth

ASTM E84	(2015b) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2014) Motors and Generators
NEMA MG 10	(2013) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code
NFPA 701	(2015) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems (SCS)Indoor Advantage

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone
PL 109-58	Energy Policy Act of 2005 (EPAct05)

UNDERWRITERS LABORATORIES (UL)

UL 181	(2013) Factory-Made Air Ducts and Air Connectors
UL 1995	(2015) Heating and Cooling Equipment
UL 586	(2009; Reprint Sep 2014) Standard for High-Efficiency Particulate, Air Filter Units
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 705	(2004; Reprint Dec 2013) Standard for Power Ventilators
UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL 900	(2015) Standard for Air Filter Units
UL Bld Mat Dir	(2012) Building Materials Directory

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams shall be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Labels shall be in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Outside Air Make-up Unit	OSAMU # 1-16
Exhaust Fan Number	EF - # 1-16
Multi V Indoor Unit	MVIU # 1-16
Multi V Air Source Unit	MVASU # 1-16
RESERVED	
RESERVED	

Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels shall be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
½ thru 1 3/8 inch	1/2 inch
1/2 thru 2 3/8 inch	3/4 inch
1/2 inch and larger	1 1/4 inch

1.2.3 Color Coding

Color coding of all piping systems shall be in accordance with MIL-STD-101.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

1.3.1 Shop Drawings

Detail Drawings; G

1.3.2 Product Data

Metallic Flexible Duct
Insulated Nonmetallic Flexible Duct Runouts
Duct Connectors
Duct Access Doors; G
Manual Balancing Dampers; G
Acoustical Duct Liner
Diffusers
Registers and Grilles
Louvers
Air Vents and Goosenecks
Centrifugal Fans
In-Line Centrifugal Fans
Outside Air Make-up Units
Multi VIndoor Units
Multi V Air Source Units
Unit Heaters
Test Procedures
Diagrams; G

1.3.3 Test Reports

Performance Tests; G

1.3.4 Certificates

Certification

1.3.5 Manufacturer's Instructions

Manufacturer's Installation Instructions
Operation and Maintenance Training

1.3.6 Operation and Maintenance Data

Operation and Maintenance Manuals; G

Centrifugal Fans; G
In-Line Centrifugal Fans; G
Outside Air Make-up Units
Multi V Indoor Units
Multi V Air Source Units

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or Energy Star certified product categories, equipment selected shall have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement.

These specifications conform to the efficiency requirements as defined in Public Law PL 109-58, "Energy Policy Act of 2005" for federal procurement of energy-efficient products. Equipment having a lower efficiency than Energy Star or FEMP requirements may be specified if the designer determines the equipment to be more life-cycle cost effective using the life-cycle cost analysis methodology and procedure in 10 CFR 436.

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Manufacturer shall provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations. Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Used as Refrigerants

Minimize releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's by complying with all applicable sections of 40 CFR 82 Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of equipment containing refrigerants must comply with the following:

a. Do not knowingly vent or otherwise release into the environment, Class I or Class II substances used as a refrigerant.

b. Do not open appliances without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices for evacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

c. Only persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification, can conduct work on appliances containing refrigerant.

In addition, provide copies of all applicable certifications to the Contracting Officer at least 14 calendar days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

a. Proof of Technician Certification

b. Proof of Equipment Certification for recovery or recycling equipment.

c. Proof of availability of certified recovery or recycling equipment.

1.4.4 Use of Ozone Depleting Substances, Other than Refrigerants

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses include:

a. Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

b. Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays.

c. Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial cabling.

d. Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

Request a waiver if a facility requirement dictates that a prohibited material is necessary to achieve project goals. Submit the waiver request in writing to the Contracting Officer. The waiver will be evaluated and dispositioned.

1.4.5 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.6 Test Procedures

Submit proposed test procedures and test schedules for the ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

2.2 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization.

2.3 STANDARD PRODUCTS

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, and balancing dampers. All energy consuming HVAC equipment must be Energy Star or Federal Energy management Program (FEMP) designated efficiency.

a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.

b. Prior to this two year period, these standard products shall have been sold on the commercial market using advertisements in manufacturers' catalogs or brochures. These manufacturers' catalogs, or brochures shall have been copyrighted documents or have been identified with a manufacturer's document number.

c. Provide equipment items that are supported by a service organization. In product categories covered by Energy Star or the Federal Energy Management Program, provide equipment that is listed on the Energy Star Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.4 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8 inch high; identification plates larger than 1-1/2 inches high shall be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2 inches high and larger shall have beveled edges. Install identification plates using a compatible adhesive.

2.5 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard.

2.6 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

2.7 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.9 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

2.10 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.11 DUCT SYSTEMS

2.11.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components that complies with SMACNA 1966, as supplemented and modified by this specification.

a. Ductwork shall be constructed meeting the requirements for the duct system static pressure specified in APPENDIX D of Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

a Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

b. Provide ductwork that meets the requirements of Seal Class A.

c. Provide ductwork that meets the requirements of Seal Class A.

c. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant.

2.11.1.2 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 5 feet. Provide runouts that are pre-insulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.11.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardant fabrics" in UL Bld Mat Dir.

ASTM A167

2.11.2 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown.

Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.11.5 Manual Balancing Dampers

a. Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators.

b. Unless otherwise indicated, provide opposed blade type multi-leaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide access doors or panels in hard ceilings, partitions and walls for access to all concealed damper operators and damper locking setscrews. Coordinate location of doors or panels with other affected contractors.

c. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

2.11.5.1 Square or Rectangular Dampers

2.11.5.1.1 Duct Height 12 inches and Less

2.11.5.1.1.1 Frames

Width	Height	Galvanized Steel Thickness	Length
Maximum 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches
More than 19 inches	Maximum 12 inches	Minimum 16 gauge	Minimum 3 inches

2.11.5.1.1.2 Single Leaf Blades

Width	Height	Galvanized Steel Thickness	Length
Maximum 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches
More than 19 inches	Maximum 12 inches	Minimum 16 gauge	Minimum 3 inches

2.11.5.1.1.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Axle shafts shall extend through standoff bracket and hand quadrant.

Width	Height	Material	Square Shaft
Maximum 19 inches	Maximum 12 inches	Galvanized Steel	Minimum 3/8 inch
More than 19 inches	Maximum 12 inches	Galvanized Steel	Minimum 1/2 inch

2.11.5.1.1.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings. Shaft bearings configuration shall be a pressed fit to provide a tight joint between blade shaft and damper frame.

Width	Height	Material
Maximum 19 inches	Maximum 12 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
More than 19 inches	Maximum 12 inches	oil-impregnated bronze

2.11.5.1.1.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Stand-off distance shall be a minimum of 2 inches off the metal duct surface. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

2.11.5.1.1.6 Finish

Mill Galvanized

2.11.5.1.2 Duct Height Greater than 12 inches

2.11.5.1.2.1 Dampers

Provide dampers with multi-leaf opposed-type blades.

2.11.5.1.2.2 Frames

Maximum 48 inches in height; maximum 48 inches in width; minimum of 16 gauge galvanized steel, minimum of 5 inches long.

2.11.5.1.2.3 Blades

Minimum of 16 gauge galvanized steel; 6 inch nominal width.

2.11.5.1.2.4 Blade Axles

To support the blades of round dampers, provide galvanized square steel shafts supporting the blade the entire duct diameter frame-to-frame. Axle shafts shall extend through standoff bracket and hand quadrant.

2.11.5.1.2.5 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic equivalent to nylon. Shaft bearings configuration shall be a pressed fit to provide a tight joint between blade shaft and damper frame.

2.11.5.1.2.6 Blade Actuator

Minimum 1/2 inch diameter galvanized steel.

2.11.5.1.2.7 Blade Actuator Linkage

Mill Galvanized steel bar and crank plate with stainless steel pivots.

2.11.5.1.2.8 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Stand-off distance shall be a minimum of 2 inches off the metal duct surface. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

2.11.5.1.2.9 Finish

Mill Galvanized

2.11.5.2 Round Dampers

2.11.5.2.1 Frames

Size	Galvanized Steel Thickness	Length
4 to 20 inches	Minimum 20 gauge	Minimum 6 inches
22 to 30 inches	Minimum 20 gauge	Minimum 10 inches
32 to 40 inches	Minimum 16 gauge	Minimum 10 inches

2.11.5.2.2 Blades

Size	Galvanized Steel Thickness
4 to 20 inches	Minimum 20 gauge
22 to 30 inches	Minimum 16 gauge
32 to 40 inches	Minimum 10 gauge

2.11.5.2.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Axle shafts shall extend through standoff bracket and hand quadrant.

Size	Shaft Size and Shape
4 to 20 inches	Minimum 3/8 inch square
22 to 30 inches	Minimum 1/2 inch square
32 to 40 inches	Minimum 3/4 inch square

2.11.5.2.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic equivalent to nylon. Shaft bearings configuration shall be a pressed fit to provide a tight joint between blade shaft and damper frame.

Size	Material
4 to 20 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
22 to 30 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
32 to 40 inches	oil-impregnated bronze, or stainless steel sleeve bearing

2.11.5.2.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Stand-off distance shall be a minimum of 2 inches off the metal

duct surface. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

2.11.5.2.6 Finish

Mill Galvanized

2.11.6 Automatic Balancing Dampers

Provide dampers as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.11.9 Air Supply And Exhaust Air Dampers

Where outdoor air supply and exhaust air dampers are required they shall have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:

a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.

b. All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

2.11.10 Air Deflectors and Branch Connections

Provide air deflectors at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors, except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors. Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors, also called turning vanes, in 90 degree elbows.

2.11.13 Diffusers, Registers, and Grilles

Provide factory-fabricated units of aluminum that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated. Provide opposed blade type volume dampers for all diffusers and registers.

2.11.13.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.11.13.2 Perforated Plate Diffusers

Provide adjustable one-way, two-way, three-way, or four-way air pattern controls as indicated. Provide diffuser faceplates that do not sag or deflect when operating under design conditions.

2.11.13.5 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Achieve four-way directional control by a grille face by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.11.13.6 Registers

Double-deflection supply registers. Provide manufacturer-furnished volume dampers. Provide volume dampers of the group-operated, opposed-blade type and key adjustable by inserting key through face of register. Operating mechanism shall not project through any part of the register face. Provide exhaust and return registers as specified for supply registers, except provide exhaust and return registers that have a single set of nondirectional face bars or vanes having the same appearance as the supply registers.

2.11.14 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 07 60 00 FLASHING AND SHEET METAL, 08 91 00 METAL WALL AND DOOR LOUVERS.

2.11.15 Air Vents, Penthouses, and Goosenecks

Fabricate air vents and goosenecks from galvanized steel sheets with galvanized structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.11.16 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.12 AIR SYSTEMS EQUIPMENT

2.12.1 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The

sound power level of the fans shall not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 120 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

2.12.1.2 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self-aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide motors with totally enclosed enclosure. Provide magnetic motor starters across-the-line with general-purpose enclosures. Provide remote manual switch with pilot indicating light where indicated.

2.12.2 Coils

Provide fin-and-tube type coils constructed of seamless copper or red brass tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Provide copper tube wall thickness that is a minimum of 0.020 inches. Provide red brass tube wall thickness that is a minimum of 0.035 inches. Provide aluminum fins that are 0.0055 inch minimum thickness. Provide copper fins that are 0.0045 inch minimum thickness. Provide casing and tube support sheets that are not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Test each coil at the factory under water at not less than 400 psi air pressure and make suitable for 200 psi working pressure and 300 degrees F operating temperature unless otherwise stated. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.

2.12.2.1 Direct-Expansion Coils

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests.

2.12.2.5 Electric Heating Coil

Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. Provide duct- or unit-mounted coil. Provide [nickel chromium resistor, single stage, strip] [nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.

2.12.3 Air Filters

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.12.3.1 Extended Surface Pleated Panel Filters

Provide 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 500 fpm that does not exceed 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.12.3.9 Holding Frames

Fabricate frames from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.12.3.10 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 3-7/8 inches in diameter, with white dials with black figures, and graduated in 0.01 inch of water, with a minimum range of 1 inch of water beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure tips with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of 1/4 inch diameter vinyl tubing, and all hardware and accessories for gauge mounting.

2.13 AIR HANDLING UNITS

2.13.2 Factory-Fabricated Air Handling Units

Provide single-zone draw-through type or single-zone blow-through type units as indicated. Units shall include fans, coils, airtight insulated casing, prefilters, secondary filter sections, adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, pan vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit shall be suitable to fit space allotted to the unit with the capacity indicated. Provide air handling unit that is rated in accordance with AHRI 430 and AHRI certified for cooling.

2.13.2.1 Casings

Provide the following:

a. Casing sections 2 inch double wall type, constructed of a minimum 18 gauge galvanized steel, or 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304.Inner casing of double-wall units that are a minimum 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.

b. Individually removable exterior panels with standard tools. Removal shall not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.

c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 18 gauge outer and 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 12 inches wide by 12 inches high. Access doors shall be a minimum 24 inches wide, the full height of the unit casing or a minimum of 6 foot, whichever is less.

d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 16 gauge corrosion resisting sheet steel conforming to ASTM A167, Type 304, conforming to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Coils shall be individually removable from the casing.

e. Casing insulation that conforms to NFPA 90A. Double-wall casing sections handling conditioned air shall be insulated with not less than 2 inches of 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Double wall insulation shall be completely sealed by inner and outer panels.

f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors and casing sections.

g. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.

h. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections where indicated.

2.13.2.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.13.2.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.13.2.4 Fans

Provide the following:

a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.

b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.

c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating.

d. Motor sheaves that are variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by AHRI Guideline D. Where fixed sheaves are required, the use of variable pitch sheaves is allowed during air balance, but replace them with an appropriate fixed sheave after air balance is completed. Select variable pitch sheaves to drive the fan at a speed that produces the specified capacity when set at the approximate midpoint of the sheave adjustment. Furnish motors for V-belt drives with adjustable bases, and with totally enclosed enclosures.

e. Motor starters of across-the-line type with general-purpose enclosure. Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to AMCA 300, ASHRAE 68(, or AHRI 260 I-P).

2.13.2.5 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.16 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Factory painting that has been damaged prior to acceptance by the Contracting Officer shall be field painted in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.17 SUPPLEMENTAL COMPONENTS/SERVICES

2.17.2 Refrigerant Piping

The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

2.17.4 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.17.5 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.17.6 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.17.7 Controls

The requirements for controls are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS 23 09 23.13 20 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

PART 3 EXECUTION

3.2 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.3 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional 3 feet.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.3.1 Condensate Drain Lines

Provide water seals in the condensate drain from all units except Multi V Indoor Units. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.3.2 Equipment and Installation

Provide frames and supports for air handling units, fans, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. Provide concrete for Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.3.4 Flexible Duct

Install, where indicated, pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.3.5 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.3.8 Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C916, Type I, NFPA 90A, UL 723, and ASTM E84. Provide top and

bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA 1966. Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA 1966 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

3.3.9 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.3.10 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums up to the point where the outdoor air reaches the conditioning unit.

3.3.11 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.3.13 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.4 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 6 inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 14 calendar days before being loaded.

3.5 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.6 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are

enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.7 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Build framed, prepared openings for square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

3.7.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

3.7.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

3.7.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.7.4 Closure Collars

Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

3.7.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.8 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

3.8.1 Temperatures less than 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

3.8.4 Finish Painting

The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.5 Color Coding Scheme for Locating Hidden Utility Components

Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 3/8 inch diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks follow completion of the finished surface on which the disks are to be fastened. Provide color code board that is approximately 3 foot wide, 30 inches high, and 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1/16 transparent plastic cover. Make the color code symbols approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount the color code board in the mechanical or equipment room. Make the color code system as indicated below:

Color	System	Item	Location
[_____]	[_____]	[_____]	[_____]

3.9 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.11 DUCTWORK LEAK TESTS

The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.13 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.14 PERFORMANCE TESTS

After testing, adjusting, and balancing is complete as specified, test each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Record the testing during the applicable season. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer. Provide tests that cover a period of not less than 14 days for each system and demonstrate that the entire system is functioning according to the specifications. Make coincidental chart recordings at points indicated on the drawings for the duration of the time period and record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

Submit test reports for the performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

3.15 CLEANING AND ADJUSTING

Thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.16 OPERATION AND MAINTENANCE

3.16.1 Operation and Maintenance Manuals

Submit 6 manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under 1.3.6 Operation and Maintenance Data

3.16.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 4 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015; INT 12 2016) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2014) Motors and Generators
NEMA MG 10	(2013) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.6 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.6.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.6.3 High Efficiency Motors

1.6.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.6.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium

induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.6.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1.34 kilowatts (1 horsepower) and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 Not used.

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located

outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of

the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 Degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F must receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
11/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.11 PART 1	(2014) American National Standard Electroacoustics – Octave-Band and Fractional-Octave-Band Filters – Part 1: Specifications
ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 203	(1990; R 2011) Field Performance Measurements of Fan Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2010) Ventilation for Acceptable Indoor Air Quality
ASHRAE HVAC APP IP HDBK	(2011) HVAC Applications Handbook, I-P Edition
ASHRAE HVAC APP SI HDBK	(2015) HVAC Applications Handbook, SI Edition

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002; 6th ed) National Standards for Total System Balance
AABC MN-4	(1996) Test and Balance Procedures

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV	(2006) Procedural Standards for Measurements and Assessment of Sound and Vibration
NEBB PROCEDURAL STANDARDS	(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1858	(2004) HVAC Sound and Vibration Manual - First Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council

b. COTR: Contracting Officer's Technical Representative

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class “A” leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems)

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

n. TAB Agency: TAB Firm

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

r. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.
Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

1.3.1 Air Distribution Systems

Test, adjust, and balance system[s] (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation. The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit three copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21days prior to the start of TAB field measurements.

1.3.4 Related Requirements

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Specific requirements relating to Reliability Centered Maintenance (RCM) principals and Predictive Testing and Inspection (PTI), by the construction contractor to detect latent manufacturing and installation defects must be followed as part of the Contractor's Quality Control program. Refer to the paragraph SUSTAINABILITY for detailed requirements.

Requirements for price breakdown of HVAC TAB work are specified in Section 01 20 00.00 20 PRICE AND PAYMENT PROCEDURES.

Requirements for construction scheduling related to HVAC TAB work are specified in Section 01 32 17.00 20 COST LOADED NETWORK ANALYSIS SCHEDULES (NAS).

1.4 SUBMITTALS

1.4.1 Preconstruction Submittals

Records of Existing Conditions; G

Independent TAB Agency and Personnel Qualifications; G

TAB Design Review Report; G

TAB Firm; G

Designation of TAB Team Assistants; G

Designation of TAB Team Engineer; G or TAB Specialist; G

Designation of TAB Team Field Leader; G

1.4.2 Shop Drawings

TAB Schematic Drawings and Report Forms; G

1.4.3 Product Data

Equipment and Performance Data; G

TAB Related HVAC Submittals; G

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer.

TAB Procedures; G

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration; G

Systems Readiness Check; G

TAB Execution; G

TAB Verification; G

1.4.4 Test Reports

Completed Pre-Final DALT Report; G

Certified Final DALT Report; G

Prerequisite HVAC Work Checkout List For Proportional Balancing; G

Certified Final TAB Report for Proportional Balancing; G

Prerequisite HVAC Work Checkout List For Season 1; G

Certified Final TAB Report for Season 1; G

Prerequisite HVAC Work Checkout List For Season 2; G

Certified Final TAB Report for Season 2; G

TAB Design Review Report; G

TAB Report for Season 1; G

TAB Report for Season 2; G

1.4.5 Certificates

Independent TAB Agency and Personnel Qualifications; G

DALT and TAB Submittal and Work Schedule; G

TAB Pre-Field Engineering Report; G

Instrument Calibration Certificates; G

DALT and TAB Procedures Summary; G

Completed Pre-Final DALT Work Checklist; G

Advance Notice of Pre-Final DALT Field Work; G

Advance Notice of TAB Field Work for Proportional Balancing; G

Advance Notice of TAB Field Work for Season 1; G

Advance Notice of TAB Field Work for Season 2 G

TAB Firm; G

Design Review Report; G

Pre-field DALT Preliminary Notification; G

Advanced Notice for Season 1 TAB Field Work; G

Prerequisite HVAC Work Check Out List For Season 1; G

Advanced Notice for Season 2 TAB Field Work; G

Prerequisite HVAC Work Check Out List For Season 2; G

1.5 QUALITY ASSURANCE

1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.5.1.1 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.1.2 Qualifications

a. TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems building systems commissioning and the measuring of sound and vibration in environmental systems.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

b. TAB Specialist

The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

c. TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.

1.5.1.3 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.2 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.2.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheet metal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.2.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.2.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently

installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of one 8 hour workday duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

(1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise Season 1 and Season 2 TAB field check.

1.5.2.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.3 Project/Site Conditions

1.5.3.1 DALT and TAB Services to Obtain Existing Conditions

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct this DALT and TAB work in accordance with the requirements of this section.

1.5.4 Sequencing and Scheduling

1.5.4.1 Projects with Phased Construction

This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase.

a. Phasing of Work

1.5.4.2 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.
Submit this schedule, and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

Pre-Field TAB Engineering Report: Within 15 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List For Season 1 and Advanced Notice For Season 1 TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit Season 1 prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of Season 1 TAB field work.
Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

Submit Season 1 TAB Report: Within 15 calendar days after completion of Season 1 TAB field work, submit Season 1 TAB report.

Season 1 TAB Field Check: 30 calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work; submit Season 1 TAB report; and conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within 150 calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within 15 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 TAB Field Check: 30 calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work; submit Season 2 TAB report; and conduct Season 2 field check.

Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 field data check, complete TAB work.

a. TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

b Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.5.4.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.5.5 Subcontractor Special Requirements

Perform all work in this section in accordance with the paragraph SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, stating that all contract requirements of this section must be accomplished directly by a first tier subcontractor. No work may be performed by a second tier subcontractor.

1.5.6 Instrument Calibration Certificates

It is the responsibility of the TAB firm to provide instrumentation that meets the minimum requirements of the standard under which the TAB Firm's qualifications are approved for use on a project. Instrumentation must be in proper operating condition and must be applied in accordance with the instrumentation's manufacturer recommendations.

All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing. All instrumentation must be calibrated within no later than one year of the date of TAB work or government acceptance testing field work.

1.5.7 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB

instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.8 Sustainability

Contractor must submit the following as part of the Quality Control Plan for acceptance testing:

a. List all test equipment to be used, including its manufacturer, model number, calibration date, and serial number.

b. Certificates of test personnel qualifications and certifications. Provide certification of compliance with 40 CFR 82.

c. Proof of equivalency if the contractor desires to substitute a test requirement.

Perform the following PTI as an integral part of the TAB process per the most recent edition of the NASA RCBEA GUIDE:

Compressors:
- a. Vibration Analysis
- b. Balance Test and Measurement
- c. Alignment (laser preferred)
- d. Lubricating Oil Test
- e. Thermodynamic Performance Test
- f. Hydraulic Oil Test (optional)

Fans:
- a. Vibration Analysis
- b. Balance Test and Measurement
- c. Alignment (laser preferred)
- d. Lubricating Oil Test
- e. Thermodynamic Performance Test

Heat Exchangers (General):
- a. Hydrostatic Test
- b. Airborne Ultrasonic Test
- c. Thermodynamic Performance Test

Heat Exchangers (Condenser Air Cooled):
- a. Hydrostatic Test
- b. Thermodynamic Performance Test

HVAC Ducts:
- a. Operational Test
- b. Ductwork Leak Testing (DALT); Pre-Final DALT report, Final DALT report

Piping Systems:

a. Vibration Analysis
b. Infrared Thermography

1.5.9 Qualifications

1.5.9.1 TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems building systems commissioning and the measuring of sound and vibration in environmental systems.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.9.2 TAB Specialist

The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.9.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process specified in Section 23 08 00.00 10 COMMISSIONING OF HVAC SYSTEMS.

1.5.9.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that

the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.10 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.10.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheet metal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.10.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.10.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of one 8 hour workday duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

(1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise Season 1 and Season 2 TAB field check.

1.5.10.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.11 Test Reports

1.5.11.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition, provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.11.2 Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1)Open office with 102, Open office 125, Conference 105, Deputy Commander 112. Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the Season I and Season 2 TAB Report.

c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.

d. Static Pressure Profiles: Report static pressure profiles for air duct systems including:

i. Outside air ventilation system.
ii Men 115 – Women 114 HVAC System.
iii. Men 122 – Women 123 HVAC System.

Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit, and also at the following locations:

Main Duct: Take readings at four locations along the full length of the main duct, 25 percent, 50 percent, 75 percent, and 100 percent of the total duct length.

Floor Branch Mains: Take readings at floor branch mains served by a main duct vertical riser.

Branch Main Ducts: Take readings at branch main ducts.

e. Duct Traverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, Paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

1.7 SEQUENCING AND SCHEDULING

1.7.1 Projects with Phased Construction

This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase.

1.7.2 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

Submit this schedule and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

Pre-Field TAB Engineering Report: Within 15 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List For Season 1 and Advanced Notice For Season 1 TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit Season 1 prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of Season 1 TAB field work.

Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work; submit Season 1 TAB report; and conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.
Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within 150 calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work; submit Season 2 TAB report; and conduct Season 2 field check.
Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 field data check, complete TAB work.

1.7.2.1 TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

1.7.2.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.7.2.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.
(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.8 WARRANTY

Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 2 years from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 1 year contractor installation warranty.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

3.2 PRE-DALT/TAB MEETING

Meet with the Contracting Officer's technical representative (COTR) to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.3 DALT PROCEDURES

3.3.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

3.3.2 Advance Notice of Pre-Final DALT Field Work Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.

3.3.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

3.3.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 746 Pa (3-inch) water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

3.3.5 Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.

TAB supervisor shall review, approve and sign the Pre-Final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-Final DALT Report data can commence. After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

3.3.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

3.3.8 Certified Final DALT Report

On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval. On successful completion of all field checks of the Pre-Final DALT Report data for all systems, the TAB Supervisor shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB to the Contracting Officer for approval.

3.3.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

3.4.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the requirements of AABC MN-1 or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.
Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section. The only air flow reporting which can be deferred until the Season 2 is that data which would be affected in terms of accuracy due to outside ambient conditions.

3.4.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.4.3 TAB Air Distribution Systems

3.4.3.1 Units With Coils

Report heating and cooling performance capacity tests for DX coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For units with capacities of 7.5 tons (90,000 Btu) or less, such as VRF Indoor Units.

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, and exhaust fans and), coils, ducts, plenums, mixing boxes, terminal units, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

3.4.3.5 Makeup Air Units

Makeup air unit systems including fans, coils, ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

3.4.3.8 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

3.4.5 Sound Measurement Work

3.4.5.1 Areas to Be Sound Measured

In the following spaces, measure and record the sound power level for each octave band listed in ASHRAE HVAC APP SI HDBK (ASHRAE HVAC APP IP HDBK) Noise Criteria:

a. All HVAC mechanical rooms, including machinery spaces and other spaces containing HVAC power drivers and power driven equipment.

b. All spaces sharing a common barrier with each mechanical room, including rooms overhead, rooms on the other side of side walls, and rooms beneath the mechanical room floor.

c. VRF System: Rooms: 102

d. VRF System: Rooms: 106

e. VRF System: Rooms: 112

3.4.5.2 Procedure

Measure sound levels in each room, when unoccupied except for the TAB team, with all HVAC systems that would cause sound readings in the room operating in their noisiest mode. Record the sound level in each octave band. Attempt to mitigate the sound level and bring the level to within the specified ASHRAE ASHRAE HVAC APP IP HDBK noise criteria goals, if such mitigation is within the TAB team's control.

State in the report the ASHRAE HVAC APP IP HDBK noise criteria goals. If sound level cannot be brought into compliance, provide written notice of the deficiency to the Contractor for resolution or correction.

3.4.5.3 Timing

Measure sound levels at times prescribed by AABC or NEBB or TABB.

3.4.5.4 Meters

Measure sound levels with a sound meter complying with ASA S1.4, Type 1 or 2, and an octave band filter set complying with ASA S1.11 PART 1. Use measurement methods for overall sound levels and for octave band sound levels as prescribed by NEBB.

3.4.5.5 Calibration

Calibrate sound levels as prescribed by AABC or NEBB or TABB, except that calibrators emitting a sound pressure level tone of 94 dB at 1000 hertz (Hz) are also acceptable.

3.4.5.6 Background Noise Correction

Determine background noise component of room sound (noise) levels for each (of eight) octave bands as prescribed by AABC or NEBB or TABB.

3.4.6 TAB Work on Performance Tests Without Seasonal Limitations

3.4.6.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

3.4.6.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.6.3 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

3.4.6.5 Refrigeration Units

For refrigeration compressors/condensers/condensing units, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

3.4.6.6 Coils

Report heating and cooling performance capacity tests for DX for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For units with capacities of 26370 Watts (7.5 tons (90,000 Btu)) or less, such as VRF Indoor Units.

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.7 TAB Work on Performance Tests With Seasonal Limitations

3.4.7.1 Performance Tests

Accomplish proportional balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy. Accomplish proportionate balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy.

3.4.7.2 Season Of Maximum Load

Visit the contract site for at least two TAB work sessions for Season 1 and Season 2 field measures. Visit the contract site during the season of maximum heating load and visit the contract site during the season of maximum cooling load, the goal being to TAB the operational performance of the heating systems and cooling systems under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the heating systems and cooling systems. Visit the contract site for at least two TAB work sessions for TAB field measurements. Visit the contract site during the season of maximum heating load and visit the contract site during the season of maximum cooling load, the goal being to TAB the operational performance of the heating systems and cooling systems under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the heating systems and cooling systems.

3.4.7.3 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.7.4 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

3.4.7.6 Refrigeration Units

For refrigeration compressors/condensers/condensing units, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

3.4.7.7 Coils

Report heating and cooling performance capacity tests for DX for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For units with capacities of 26370 Watts (7.5 tons (90,000 Btu)) or less, VRF Indoor Units.

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.8 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves if required to obtain air flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

3.4.9 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.4.10 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB

After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the

specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

3.4.11 Quality Assurance - COTR TAB Field Acceptance Testing

3.4.11.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (air quantities, air motion, sound level readings) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All air handling units.

Group 2: 25 percent of the VRF Indoor Units.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

3.4.11.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to be found. This additional field testing is up and above the original 25 percent of the reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3.4.11.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

3.7 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - DALT and TAB
Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE
Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.

b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.

d. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.

e. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph CONSTRUCTION DEFICIENCIES. Correct each deficiency as soon as practical with the Contracting Officer, and submit revised schedules and other required documentation.

f. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

g. Give Notice of Testing: Submit advance notice of proportional balancing, Season 1, and Season 2 TAB field work accompanied by completed prerequisite HVAC Work List

h. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.

Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.

e. Design Review Report: Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

f. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.

Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

g. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.

h. Technical Assistance: Provide technical assistance to the DALT and TAB field work.

i. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph CONSTRUCTION DEFICIENCIES. Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.

j. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.

b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.

c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.

d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.

e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.

f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.

g. A thorough checklist of the work items and inspections that need to be accomplished before the Season 1 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 1 Pre-TAB Work Checklist before the Season 1 TAB field work can be accomplished.

h. A thorough checklist of the work items and inspections that need to be accomplished before the Season 2 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 2 Pre-TAB Work Checklist before the Season 2 TAB field work can be accomplished.

i. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Design Review Report

Submit report containing the following information:

a. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

b. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

4. Completed Pre-Final DALT Work Checklist

Report the data for the Pre-Final DALT Report meeting the following requirements:

a. Submit a copy of the approved DALT and TAB Procedures Summary: Provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Node numbers shall be included in the completed report forms to identify each duct section.

c. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.

d. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments are to be calibrated within one year of the date of use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and Technology.

e. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

5. Final DALT Report

On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer for approval.

6. TAB Reports: Submit TAB Report for Proportional Balancing, Season 1, and Season 2 in the following manner:

a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.

c. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the Season I and Season 2 TAB Report.

d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.

e. Air Static Pressure Profiles: Report static pressure profiles for air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

f. Duct Transverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This shall include all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, and paragraph 8.3, "Location of Traverse Plane".

g. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings shall provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

h. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.

j. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field

engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below. Include the major items listed in this schedule in the project network analysis schedule required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS).

Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.

Submit the DALT and TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

Submit the DALT and TAB Work Procedures Summary: within 14 days after receipt of the initial approved DALT and TAB Work Execution Schedule.

Meet with the COTR at the Pre-DALT/TAB Meeting: Within 28 calendar days after receipt of the approved initial DALT/TAB Execution Schedule.

Submit Design Review Report: Within 56 calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

Conduct measurements and submit the Record of Existing Facility Conditions: within 28 days after receipt of approved DALT and TAB Work Procedures Summary.

Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Contracting Officer an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist for the subject duct system.

Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's technical representative (COTR) will select the project ductwork sections to be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.

Submit Pre-Final DALT Report: Within two working days after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

Quality Assurance - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Contracting Officer.

Submit Final DALT Report: Within 14 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.
Advance Notice of Season 1 TAB Field Work: At a minimum of 14 calendar days prior to Season 1 TAB Field Work, submit advance notice of TAB field work accompanied by completed Season 1 Pre-TAB Work Checklist.
Season 1 TAB Field Work: At a minimum of 84 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

Submit Season 1 TAB Report: Within 14 calendar days after completion of Season 1 TAB field work, submit initial Season 1 TAB report.

Season 1 Quality Assurance - COTR TAB Field Check: 30 calendar days after initial Season 1 TAB report is approved by the Contracting Officer, conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work and submit final.

Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.
Advance Notice of Season 2 TAB Field Work: At a minimum of 126 calendar days after CCD, submit advance notice of Season 2 TAB field work accompanied by completed Season 2 Pre-TAB Work Checklist.
Season 2 TAB Field Work: Within 14 calendar days after date of advance notice of Season 2 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within 14 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 Quality Assurance - COTR TAB Field Checks: 28 calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within 14 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

Receive the approved TAB report: Within calendar 21 days, receive the report from Contracting Officer.

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		Outside Air Make-up Unit # 1-16			

Duct System Static Pressure, in inches W.C.	for Supply	4	4	2	2
	for Return	N/A			
	for Exhaust	2			
	for Outside Air	2	2	1	1

System Rectangular Duct SMACNA Leak Class	for Supply	4			
	for Return	N/A			
	for Exhaust				
	for Outside Air	2			
Duct Test Pressure, in inches W.C.	for Supply	4			
	for Return	2			
	for Exhaust				
	for Outside Air	2			

-- End of Section --

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
02/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2015b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2015) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C1136	(2012) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	(2013) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

ASTM C534/C534M	(2014) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2015) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2015) Standard Specification for Cellular Glass Thermal Insulation
ASTM C610	(2015) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C795	(2008; R 2013) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2014) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D2863	(2013) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM E2231	(2015) Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E84	(2015b) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2014) Standard Test Methods for Water Vapor Transmission of Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1999) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2015) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T403 OM	(2010) Bursting Strength of Paper

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-PRF-19565	(1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

UNDERWRITERS LABORATORIES (UL)

UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL 94	(2013; Reprint Jul 2015) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated.

1.2.2 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the materials meet all other requirements of this section. The minimum recycled material content of the following insulation are:

	75
Fiberglass	20-25 percent glass cullet by weight
Rigid Foam	9 percent recovered material

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Information only.

Submit the three submittal types, 1.3.1 Shop Drawings, 1.3.2 Product Data, and 1.3.4 Manufacturer's Instructions at the same time for each system.

1.3.1 Shop Drawings

MICA Plates; G
Pipe Insulation Systems and Associated Accessories
Duct Insulation Systems and Associated Accessories

1.3.2 Product Data

Pipe Insulation Systems; G
Duct Insulation Systems; G

1.3.3 Samples

Thermal Insulation; G
Display Samples; G

1.3.4 Manufacturer's Instructions

Pipe Insulation Systems; G
Duct Insulation Systems; G

1.3.5 Closeout Submittals

Reduce Volatile Organic Compounds (VOC) for Caulking, Sealant and Adhesive Materials;
Recycled Content for Pipe and Ductwork Insulation Materials;

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material,

date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

2.2 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet and in conjunction with the MICA plates booklet (SD-02). Annotate the product data to indicate which MICA plate is applicable.

2.2.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

2.2.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.

2.3 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.1 - IP. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

2.3.1 Adhesives

2.3.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2.3.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2.3.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. To resist mold/mildew, lagging adhesive shall meet ASTM D5590 with 0 growth rating. Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Adhesive shall be MIL-A-3316, Class 1, pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.3.1.4 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

2.3.2 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.3.3 Corner Angles

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209M (ASTM B209), Alloy 3003, 3105, or 5005.

2.3.4 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.3.5 Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

2.3.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.3.7 Staples

Outward clinching type ASTM A167, Type 304 or 316 stainless steel.

2.3.8 Jackets

2.3.8.1 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209M (ASTM B209), Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.3.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.3.8.3 Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

2.3.8.4 Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

a. On ducts, piping and equipment operating below TBD degrees F or located outside shall be equipped with a vapor barrier.
b. Ducts, pipes and equipment that are located inside and that always operate above TBD degrees F shall be installed with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

2.3.9 Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible

elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.3.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. The product shall meet all physical property and performance requirements of ASTM C1136, Type I, except the burst strength shall be a minimum of 585 kPa (85 psi). ASTM D2863 Limited Oxygen Index (LOI) shall be a minimum of 31.

In addition, neither the outer exposed surface nor the inner-most surface contacting the insulation shall be paper or other moisture-sensitive material. The outer exposed surface shall be white and have an emittance of not less than 0.80. The outer exposed surface shall be paintable.

2.3.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.3.9.2.1 Vapor Barrier

The vapor barrier shall be self-adhesive 2 mils adhesive, (3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Permeability shall be less than 0.02 when tested in accordance with ASTM E96/E96M. Products shall meet UL 723 or ASTM E84 flame and smoke requirements and shall be UV resistant.

2.3.9.2.2 Vapor Retarder

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be 0.013 perms or less at 43 mils dry film thickness as determined according to procedure B of ASTM E96/E96M utilizing apparatus described in ASTM E96/E96M. The coating shall be nonflammable, fire resistant type. To resist mold/mildew, coating shall meet ASTM D5590 with 0 growth rating. Coating shall meet MIL-PRF-19565 Type II (if selected for indoor service) and be Qualified Products Database listed. All other application and service properties shall be in accordance with ASTM C647.

2.3.9.3 Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Vapor retarder shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.3.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

The PVDC film vapor retarder shall have a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 5.3 kN/m (30 lb/inch) when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.3.9.6 Vapor Barrier/Weather Barrier

The vapor barrier shall be greater than 3 ply self-adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Vapor barrier shall meet UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 1.3 MPa (185 psi) in accordance with TAPPI T403 OM. Tensile strength 0.12 kg/m (68 lb/inch) width (PSTC-1000). Tape shall be as specified for laminated film vapor barrier above.

2.3.10 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Jacket shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.3.12 Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

2.3.13 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.4 PIPE INSULATION SYSTEMS

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - IP. Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.4.1 Aboveground Cold Pipeline (-34 to 16 deg. C (-30 to 60 deg. F))

Insulation for outdoor, indoor, exposed or concealed applications, shall be as follows:

2.4.1.1 Cellular Glass

ASTM C552, Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ)) ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.4.1.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)

ASTM C547. Install in accordance with manufacturer's instructions. Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

2.4.2 Aboveground Hot Pipeline (Above 16 deg. C (60 deg. F))

Insulation for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.4.2.1 Mineral Fiber

ASTM C547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.4.2.2 Calcium Silicate

ASTM C533, Type I indoor only, or outdoors above 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket/vapor barrier.

2.4.2.3 Cellular Glass

ASTM C552, Type II and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket.

2.4.3 Aboveground Dual Temperature Pipeline

Selection of insulation for use over a dual temperature pipeline system (Outdoor, Indoor - Exposed or Concealed) shall be in accordance with the most limiting/restrictive case. Find an allowable material from paragraph PIPE INSULATION MATERIALS and determine the required thickness from the most restrictive case. Use the thickness listed in paragraphs INSULATION THICKNESS for cold & hot pipe applications.

2.5 DUCT INSULATION SYSTEMS

2.5.1.1 Rigid Insulation

Calculate the minimum thickness in accordance with ASHRAE 90.1 - IP.

2.5.1.2 Blanket Insulation

Calculate minimum thickness in accordance with ASHRAE 90.1 – SI (ASHRAE 90.1 - IP).

2.5.3 Acoustical Duct Lining

2.5.3.1 General

For ductwork indicated or specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM to be acoustically lined, provide external insulation in accordance with this specification section and in addition to the acoustical duct lining. Do not use acoustical lining in place of duct wrap or rigid board insulation (insulation on the exterior of the duct).

2.5.3.2 Duct Liner

Flexible Elastomeric Acoustical and Conformable Duct Liner Materials: Flexible Elastomeric Thermal, Acoustical and Conformable Insulation Compliance with ASTM C534/C534M Grade 1, Type II; and NFPA 90A or NFPA 90B as applicable.

2.5.4 Duct Insulation Jackets

2.5.4.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2.5.4.2 Metal Jackets

2.5.4.2.1 Aluminum Jackets

ASTM B209M (ASTM B209), Temper H14, minimum thickness of 27 gauge (0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 8 inches and larger. Provide stainless steel bands, minimum width of 1/2 inch.

2.5.4.2.2 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of (1/2 inch).

2.5.4.3 Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive (2 mils) adhesive, (3 mils) embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (2.9 mils adhesive), heavy duty white or natural).

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

3.1.1 Display Samples

Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

3.1.1.1 Pipe Insulation Display Sections

Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

3.1.1.2 Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for duct insulation exposed to weather

3.1.2 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi-layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.4 Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.6 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.7 Pipes/Ducts/Equipment That Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

e. Adjacent insulation.

f. ASME stamps.

g. Access plates of fan housings.

h. Cleanouts or handholes.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

Pipe insulation shall be continuous through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self-adhesive jacket 2 mils adhesive, (3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

The aluminum jacket or vapor barrier/weatherproofing - self-adhesive jacket 2 mils adhesive, (3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

3.2.1.2.4 Penetrating Exterior Walls

Continue the aluminum jacket required for pipe exposed to weather through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.1.2.7 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service

Terminate the insulation on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). Protect the insulation with two coats of weather barrier mastic (breather emulsion type weatherproof mastic impermeable to water and permeable to air) with a minimum total thickness of 1/16 inch. Extend the mastic out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the outer surface of the pipe insulation and caulk the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-69, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.3.2 Horizontal Pipes Larger Than 2 Inches and Below 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 80 degrees F shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 1-1/2 inches, and seal as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, and mechanical rooms, welded PVC, or aluminum shall be utilized. Pipe insulation to the 6 foot level shall be protected.

3.2.1.6 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of ASHRAE 90.1 - IP.

TABLE 1
Insulation Material for Piping
Service

	Material	Specification	Type	Class	VR/VB Req'd
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping					
	Cellular Glass	ASTM C552	II	2	No
Refrigerant Suction Piping (35 degrees F nominal)					
	Cellular Glass	ASTM C552	II	1	Yes
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552	I or II		No
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Note: VR/VB = Vapor Retarder/Vapor Barrier					

TABLE 2

Piping Insulation Thickness (mminch)
For flexible cellular foam the thickness should be 13mm instead of 15mm. Economic thickness or prevention of condensation is the basis of these tables. If prevention of condensation is the criterion, the ambient temperature and relative humidity must be stated. Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service						
	Material	Tube And Pipe Size inch				
		<1	<1.5	1.5-<4	<8	
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping						
	Cellular Glass	401.5	401.5	401.5	401.5	401.5
Refrigerant Suction Piping (35 degrees F nominal)						
	Cellular Glass	401.5	401.5	401.5	401.5	401.5
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel						
	Flexible Elastomeric Cellular	130.5	130.5	130.5	130.5	130.5
Condensate Drain Located Inside Building						
	Cellular Glass	401.5	401.5	401.5	401.5	401.5

3.2.2 Aboveground Cold Pipelines

The following cold pipelines for minus 30 to plus 60 degrees F, shall be insulated in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. This includes but is not limited to the following:

a. Make-up water.

b. Refrigerant suction lines.

c. Air conditioner condensate drains.

d. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

e. Domestic cold and chilled drinking water.

3.2.2.1 Insulation Material and Thickness

Insulation thickness for cold pipelines shall be determined using Table 2.

3.2.2.2 Factory or Field applied Jacket

Insulation shall be covered with a factory applied vapor retarder jacket/vapor barrier or field applied seal welded PVC jacket or greater than 3 ply laminated self-adhesive 2 mils adhesive, (3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe. Insulation inside the building, to be protected with an aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive 2 mils adhesive, (3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive 2 mils adhesive, (3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, and mechanical rooms, aluminum jackets or greater than 3ply vapor barrier/weatherproofing self-adhesive 2 mils adhesive, (3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, white & black, shall be provided for pipe insulation to the 6 ft level.

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 1-1/2 inches. Provide butt strips 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.

(1) The MICA plates shall detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. The MICA plates shall present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.

(2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, the detail drawings shall be technically equivalent to the edited MICA Plate submittal.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used

under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, a laminated self-adhesive (2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability (greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket or PVC jacket shall be applied. PVC jacketing requires no factory-applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with metal jacketing/flashing sealant while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof laminated self-adhesive (2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant.

3.2.4.3 PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions. Duct insulation minimum thickness and insulation level must be as listed in Table 3 and must meet or exceed the requirements of ASHRAE 90.1 - IP.

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket.

3.3.1 Duct Insulation Minimum Thickness

Table 3

Minimum Duct Insulation

	Cooling		Heating	
Duct Location	Annual Cooling Degree Days Base 65 F	Insulation R-Value (h sf F)/Btu	Annual Heating Degree Days Base 65 F	Insulation R-Value (h sf F)/Btu
Exterior of Building	<500	3.3	<500	3.3
	500 - 1150	5.0	<500	5.0
	1151 - 2000	6.5	4501-7500	6.5
	>2000	8.0	>7500	8.0
	Temperature Difference	Insulation R-Value (sm K)/W (h sf F)/Btu	Temperature Difference	Insulation R-Value (sm K)/W (h sf F)/Btu
Inside building envelope or in unconditioned spaces	<15	None required	<15	None required
	15 <TD <40	3.3	15 <TD <40	3.3
	40 <TD	5.0	40 <TD	5.0

These R-values do not include the film resistances. The required minimum thicknesses do not consider water vapor transmission and condensation. Additional insulation, vapor retarders, or both, may be required to limit vapor transmission and condensation. Where ducts are designed to convey both heated and cooled air, duct insulation shall be as required by the most restrictive condition. Where exterior walls are used as plenum walls, wall insulation shall be a required by the most restrictive condition of this section or the insulation for the building envelope. Cooling ducts are those designed to convey mechanically cooled air or return ducts in such systems. Heating ducts are those designed to convey mechanically heated air or return ducts in such systems. Thermal resistance will be measured in accordance with ASTM C518 at a mean temperature of 75 degrees F. The Temperature difference is at design conditions between the space within which the duct is located and the design air temperature in the duct. Resistance for runouts to terminal devices less than 3 m 10 feet in length need not exceed 3.3 (h sf F)/Btu. Unconditioned spaces include crawlspaces and attics.

Duct insulation minimum thickness in accordance with Table 4.

Table 4 - Minimum Duct Insulation (mm) (inches)	
Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Insulation and vapor retarder/vapor barrier shall be provided for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible run-outs (field-insulated).

e. Plenums.

f. Fresh air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf, and rigid type where exposed, minimum density 3 pcf. Insulation for both concealed or exposed round/oval ducts shall be flexible type, minimum density 3/4 pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Insulation for all exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified, the total field applied dry film thickness shall be approximately 1/16 inch. Insulation on all concealed duct shall be provided with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder/vapor barrier shall cover the collar, neck, and any un-insulated surfaces of diffusers, registers and grills. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, flexible insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate 2 mils adhesive, (3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate 2 mils adhesive, (3 mils embossed) - less than 0.0000 perm adhesive tape.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate 2 mils adhesive, (3 mils embossed) - less than 0.0000 perm adhesive tape.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches. Mechanical fasteners shall be as corrosion resistant as G60 coated galvanized steel, and shall indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.

b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder/barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried

over. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

c. Impale insulation on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.

d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a flashing sealant.

g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

Insulation and vapor barrier shall be provided for the following warm air ducts and associated equipment:.

a. Supply ducts.

b. Return air ducts.

c. Relief air ducts

d. Flexible run-outs (field insulated).

e. Plenums.

Insulation for rectangular ducts shall be flexible type where concealed, and rigid type where exposed. Insulation on exposed ducts shall be provided with a white, paint-able, factory-applied Type II jacket, or finished with adhesive finish. Flexible type insulation shall be used for round ducts, with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 16 inches apart and not more than 6 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin trimmed and bent over.

d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of tape and brushed with vapor retarder coating.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by staples spaced not more than 16 inches and not more than 6 inches from the degrees of joints. Joints shall be sealed in accordance with item "d." above.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

3.3.6 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

-- End of Section --

SECTION 23 08 00.00 10

COMMISSIONING OF HVAC SYSTEMS
01/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline (2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard (2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1429 (1994) HVAC Systems Commissioning Manual, 1st Edition

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED BD+C (2009; R 2010) Leadership in Energy and Environmental Design(tm) Building Design and Construction (LEED-NC)

1.2 DEFINITIONS

In some instances, terminology differs between the Contract and the Commissioning Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding ACG, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	ACG	NEBB	TABB
Commissioning Standard	ACG Commissioning Guideline	Procedural Standards for Building Systems Commissioning	SMACNA HVAC Commissioning Guidelines
Commissioning Specialist	ACG Certified Commissioning Agent	NEBB Qualified Commissioning Administrator	TABB Certified Commissioning Supervisor

1.3 SYSTEM DESCRIPTION

1.3.1 General

Perform Commissioning in accordance with the requirements of the standard under which the Commissioning Firm's qualifications are approved, i.e., ACG Commissioning Guideline, NEBB Commissioning Standard, or SMACNA 1429 unless otherwise stated herein. Consider mandatory all recommendations and suggested practices contained in the Commissioning Standard. Use the Commissioning Standard for all aspects of Commissioning, including qualifications for the Commissioning Firm and Specialist and calibration of Commissioning instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the Commissioning Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the Commissioning Standard, Commissioning procedures shall be developed by the Commissioning Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

1.4.1 Shop Drawings

Commissioning Plan; G

1.4.2 Product Data

Pre-Functional Performance Test Checklists; G
Functional Performance Tests; G

1.4.3 Test Reports

Commissioning Report

1.4.4 Certificates

Commissioning Firm
Commissioning Specialist

1.5 QUALITY ASSURANCE

1.5.1 Commissioning Firm

Submit certification of the proposed Commissioning Firm's qualifications to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. The firm is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the

firm loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections to be performed by the Commissioning Firm shall be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The Commissioning Firm shall be a subcontractor of the prime Contractor and shall be financially and corporately independent of all other Subcontractors. The Commissioning Firm shall report to and be paid by the prime Contractor.

1.5.2 Commissioning Specialist

1.5.2.1 General

Submit certification of the proposed Commissioning Specialist's qualifications to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date when the current Certification expires. The Commissioning Specialist shall be an ACG Certified Commissioning Agent, a NEBB Qualified Commissioning Administrator, or a TABB Certified Commissioning Supervisor and shall be an employee of the approved Commissioning Firm. Any lapses in Certification of the proposed Commissioning Specialist or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Specialist shall be described in detail. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Specialist shall be considered invalid if the Commissioning Specialist loses certification prior to Contract completion and must be performed by the approved successor.

1.5.2.2 Responsibilities

Perform all Commissioning work specified herein and in related sections under the direct guidance of the Commissioning Specialist. The Commissioning Specialist shall prepare, no later than 28 days after the approval of the Commissioning Specialist, the Commissioning Plan which will be a comprehensive schedule and will include all submittal requirements for procedures, notifications, reports and the Commissioning Report. After approval of the Commissioning Plan, revise the Contract NAS schedule to reflect the schedule requirements in the Commissioning Plan.

1.6 SEQUENCING AND SCHEDULING

Begin the work described in this Section only after all work required in related Sections has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Pre-Functional Performance Test Checklists shall be performed at appropriate times during the construction phase of the Contract.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 COMMISSIONING TEAM AND TEST FORMS AND CHECKLISTS

Designation	Function
A	Contractor's Commissioning Specialist
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing (TAB) Specialist
C	Contractor's Controls Representative
D	Design Agency Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Designate Contractor team members to participate in the Pre- Functional Performance Test Checklists and the Functional Performance Tests specified herein. In addition, the Government team members will include a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency's Representative. The team members shall be as follows:

Appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each Pre- Functional Performance Test Checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test item shall be indicated by signature and date.

3.2 TESTS

Perform the pre-functional performance test checklists and functional performance tests in a manner that essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, establish methods which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. Provide all materials, services, and labor required to perform the pre- functional performance tests checks and functional performance tests. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test.

3.2.1 Pre-Functional Performance Test Checklists

Perform Pre-Functional Performance Test Checklists, for the items indicated in Appendix A, at least 28 days prior to the start of Pre-Functional Performance Test Checks. Correct and re-inspect deficiencies

discovered during these checks in accordance with the applicable contract requirements. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Performance Test Checks.

3.2.2 Functional Performance Tests

Submit test procedures at least 28 days prior to the start of Functional Performance Tests. Submit the schedule for the tests at least 14 days prior to the start of Functional Performance Tests. Perform Functional Performance Tests for the items indicated in Appendix B. Begin Functional Performance Tests only after all Pre-Functional Performance Test Checklists have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Begin Tests with equipment or components and progress through subsystems to complete systems. Upon failure of any Functional Performance Test item, correct all deficiencies in accordance with the applicable contract requirements. The item shall then be retested until it has been completed with no errors.

3.3 COMMISSIONING REPORT

Submit the Commissioning Report, no later than 14 days after completion of Functional Performance Tests, consisting of completed Pre- Functional Performance Test Checklists and completed Functional Performance Tests organized by system and by subsystem and submitted as one package. The Commissioning Report shall also include all HVAC systems test reports, inspection reports (Preparatory, Initial and Follow-up inspections), start-up reports, TAB report, TAB verification report, Controls start-up test reports and Controls Performance Verification Test (PVT) report. The results of failed tests shall be included along with a description of the corrective action taken.

APPENDIX A

PRE-FUNCTIONAL PERFORMANCE TEST CHECKLISTS

Pre-Functional Performance Test Checklist – Multi V Heat Recovery Outdoor Unit

For Heat Recovery Outdoor Unit # 1-16:

Checklist Item	A	M	E	T	C	O
Installation						
a. Check condenser fans for proper rotation.	___	___	X	___	X	___
Electrical	A	M	E	T	C	O
a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	X	___	X	___	___
Controls	A	M	E	T	C	O
a. Unit safety/protection devices tested.	___	___	X	X	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___

Pre-Functional Performance Test Checklist – Multi V Heat Recovery Indoor Unit

For Heat Recovery Indoor Unit: _____*_____

Checklist Item						
Installation	A	M	E	T	C	O
a. Access doors/removable panels are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed.	___	___	X	X	X	___
Electrical	A	M	E	T	C	O
a. Power available to unit disconnect.	___	___	___	X	___	___
b. Power available to unit control panel.	___	___	___	X	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Coils	A	M	E	T	C	O
a. Refrigeration piping properly connected.	___	___	X	___	___	___
Controls	A	M	E	T	C	O
a. Verify proper location and installation of thermostat.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

* Contractor shall prepare one (1) Checklist Thus for each Heat Recovery Indoor Unit.

Pre-Functional Performance Test Checklist – Outside Air Make-up Unit

For Outside Air Make-up Unit: 1-16

Checklist Item						
Installation	A	M	E	T	C	O
a. Inspection and access doors are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed.	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___
Electrical	A	M	E	T	C	O
a. Power available to unit disconnect.	___	___	___	X	X	___
b. Power available to unit control panel.	___	___	___	X	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
e. Natural gas available to heat exchanger.	___	___	___	X	___	___
Coils	A	M	E	T	C	O
a. Refrigerant piping properly connected.	___	___	X	X	X	___
Controls	A	M	E	T	C	O
a. Verify proper location and installation of thermostat.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. Construction filters removed and replaced.	___	___	X	___	X	___
b. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: 1-16

Checklist Item	A	M	E	T	C	O
Installation						
a. Check condenser fans for proper rotation.	___	___	X	___	X	___
Electrical	**A**	**M**	**E**	**T**	**C**	**O**
a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	X	___	X	___	___
Controls	**A**	**M**	**E**	**T**	**C**	**O**
a. Unit safety/protection devices tested.	___	___	X	X	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___

Pre-Functional Performance Test Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: 2-16

Checklist Item	A	M	E	T	C	O
Installation						
a. Check condenser fans for proper rotation.	___	___	X	___	X	___
Electrical	**A**	**M**	**E**	**T**	**C**	**O**
a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	X	___	X	___	___
Controls	**A**	**M**	**E**	**T**	**C**	**O**
a. Unit safety/protection devices tested.	___	___	X	X	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___

Pre-Functional Performance Test Checklist – Single Zone Air Handling Unit

For Air Handling Unit: 1-16

Checklist Item	A	M	E	T	C	O
Installation						
a. Check condenser fans for proper rotation.	___	___	X	___	X	___
b. Condensate drainage is unobstructed.	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___
Electrical	A	M	E	T	C	O
a. Power available to unit disconnect.	___	___	___	X	X	___
b. Power available to unit control panel.	___	___	___	X	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls	___	___	___	X	___	___
e. Power available to electric heating coil.	___	___	___	X	___	___
Coils	A	M	E	T	C	O
a. Refrigerant piping properly connected.	___	___	X	X	X	___
Controls	A	M	E	T	C	O
a. Verify proper location and installation of thermostat.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. Construction filters removed and replaced.	___	___	X	___	X	___
b. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist – Single Zone Air Handling Unit

For Air Handling Unit: 2-16

Checklist Item	A	M	E	T	C	O
Installation						
a. Check condenser fans for proper rotation.	___	___	X	___	X	___
b. Condensate drainage is unobstructed.	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___

Electrical	A	M	E	T	C	O
a. Power available to unit disconnect.	___	___	___	X	X	___
b. Power available to unit control panel.	___	___	___	X	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls	___	___	___	X	___	___
e. Power available to electric heating coil.	___	___	___	X	___	___

Coils	A	M	E	T	C	O
a Refrigerant piping properly connected.	___	___	X	X	X	___

Controls	A	M	E	T	C	O
a. Verify proper location and installation of thermostat.	___	___	X	___	___	___

Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
c. Construction filters removed and replaced.	___	___	X	___	X	___
d. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - Unit Heater

For Unit Heater: 1-16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to unit disconnect.				X		
b. Proper motor rotation verified.				X	X	
c. Verify that power disconnect is located within sight of the unit it controls.				X		
d. Power available to electric heating coil.				X		
Controls						
a. Verify proper location and installation of thermostat.			X			
Testing, Adjusting, and Balancing (TAB)						
a. TAB Report approved.			X		X	

Pre-Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: 1-16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls	A	M	E	T	C	O
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: 2-16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls	A	M	E	T	C	O
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: 3-16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls	A	M	E	T	C	O
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: 4 -16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls	A	M	E	T	C	O
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: 5-16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls	A	M	E	T	C	O
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: 6-16

Checklist Item	A	M	E	T	C	O
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls	A	M	E	T	C	O
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report approved.	___	___	X	___	X	___

Pre-Functional Performance Test Checklist - HVAC System Controls

For MULTI-V HVAC System: 1-16

Checklist Item	A	M	E	T	C	O
Installation						
a. Layout of control panel matches drawings.	___	___	X	X	___	___
b. Framed instructions mounted in or near control panel.	___	___	X	X	___	___
c. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___
d. Control components wired to each labeled terminal strip.	___	___	X	X	___	___
e. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___
f. Control wiring labeled at all terminations, splices, and junctions.	___	___	X	X	___	___
Main Power						
a. 120 volt AC power available to panel.	___	___	___	X	___	___

Testing, Adjusting, and Balancing (TAB)	A	M	E	T	C	O
a. TAB Report submitted.	___	___	X	___	X	___

End of Appendix A -

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist – Multi V Heat Recovery Outdoor Unit

For Heat Recovery Outdoor Unit: 1-16

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system in accordance with specifications including the following: Start building indoor Heat Recovery Units to provide load for outdoor unit. Activate controls system start sequence as follows.

   a. Start indoor units. Verify control system energizes condensing unit start sequence. _____

   b. Verify and record data in 2 and 3 below.

   c. Shut off indoor equipment to verify outdoor unit de-energizes. _____

   d. Restart indoor equipment one minute after outdoor unit shut down. Verify outdoor unit restart sequence. _____

2. Verify outdoor unit amperage each phase and voltage phase to phase and phase to ground.
   Motor Full-Load Amps _____

Amperage Phase 1 _____ Phase 2_____ Phase 3_____

Voltage Ph1-Ph2 _____ Ph1-Ph3_____ Ph2-Ph3_____

Voltage Ph1-gnd _____ Ph2-gnd_____ Ph3-gnd_____

3. Record the following information:
   Ambient dry bulb temperature _____ degrees F
   Suction pressure _____ kPa gauge(psig)
   Discharge pressure _____ kPa gauge(psig)

4. Unusual vibration, noise, etc.

_____

_____

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Functional Performance Test Checklist – DX Air Cooled Condensing Unit (cont'd)

Design Agency Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist – Multi V Heat Recovery Indoor Units

The Contracting Officer will select indoor units to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent. The associated Multi V Heat Recovery Outdoor Units must be in Operation.

1. Functional Performance Test: Contractor shall demonstrate operation of selected indoor units in accordance with specifications including the following:

   a. Cooling/heating units:

   (1) Verify fan coil unit response to room temp set point adjustment.
   1. Check blower fan airflow. _____ cfm
   2. Verify proper operation of refrigerant control valve. ____
   3. Check cooling mode inlet air temperature. _____deg F
   4. Check cooling mode outlet air temperature. _____deg F
   5. Calculate cooling coil sensible capacity and compare to design:
   6. Calculated _____BTU/hr Design_____BTU/hr.
   7 Verify proper operation of refrigerant control valve. _____
   8. Check heating mode inlet air temperature. _____ deg F
   9. Check heating mode outlet air temperature. _____deg F
   10. Calculate heating coil capacity and compare to design:
   Calculated_____BTU/hr. Design_____BTU/hr

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

*The Contractor shall prepare one (1) “Spot-check” Checklist for each Indoor Unit checked.

Functional Performance Test Checklist – Outside Air Make-up Unit

For Outside Air Make-up Unit: 1-16

1. Functional Performance Test: Contractor shall verify operation of Outside Air Make-up Unit in accordance with specification including the following:

   a. The following shall be verified when the supply fan operating mode is initiated:

      (1) System safeties allow start if safety conditions are met.

   b. Occupied mode of operation.

      (1) Summer operation: The (Outdoor) air cooled condensing unit and the Outdoor Make-up Air Unit work together to provide _____ ° F ventilation air to the building's occupied spaces as specified.

      (2) Winter operation: The (outdoor) air cooled condensing unit and Outdoor Make-up Air Unit (Air Handling Unit work together to provide _____ ° F ventilation air to the building's occupied spaces as specified.

   c. Unoccupied mode of operation.
      (1) Observe that the Outdoor Make-up Air System is "off-line" (as programmed / controlled by the building's DDC System) during "unoccupied" building hours._____

   d. The following shall be verified when the supply fan off mode is initiated:
      (1) Fan de-energizes. _____

   e. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point_____.

   f. Verify safety shut down initiated by low temperature protection thermostat_____.

   g. Verify occupancy schedule is programmed into time clock / UMCS_____.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist – Air Cooled Condensing Unit

For Condensing Unit: 1-16

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system in accordance with specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

   b. Start air handling unit. Verify control system energizes condensing unit start sequence. _____

   b. Verify and record data in 2 and 3 below.

   c. Shut off air handling equipment to verify condensing unit de-energizes. _____

   d. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence. _____

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.
   Motor Full-Load Amps _____

Amperage Phase 1 _____ Phase 2_____ Phase 3_____

Voltage Ph1-Ph2 _____ Ph1-Ph3_____ Ph2-Ph3_____

Voltage Ph1-gnd _____ Ph2-gnd_____ Ph3-gnd_____

3. Record the following information:
   Ambient dry bulb temperature _____ degrees F
   Suction pressure _____ kPa gauge(psig)
   Discharge pressure _____ kPa gauge(psig)

4. Unusual vibration, noise, etc.

_____
_____

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Functional Performance Test Checklist – Air Cooled Condensing Unit (cont'd)

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist – Air Cooled Condensing Unit

For Condensing Unit: 2-16

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system in accordance with specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

   a. Start air handling unit. Verify control system energizes condensing unit start sequence. _____

   b. Verify and record data in 2 and 3 below.

   c. Shut off air handling equipment to verify condensing unit de-energizes. _____

   d. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence. _____

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.
   Motor Full-Load Amps _____

Amperage Phase 1 _____ Phase 2_____ Phase 3_____

Voltage Ph1-Ph2 _____ Ph1-Ph3_____ Ph2-Ph3_____

Voltage Ph1-gnd _____ Ph2-gnd_____ Ph3-gnd_____

3. Record the following information:
   Ambient dry bulb temperature _____ degrees F
   Suction pressure _____ kPa gauge(psig)
   Discharge pressure _____ kPa gauge(psig)

4. Unusual vibration, noise, etc.

_____

_____

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Functional Performance Test Checklist – Air Cooled Condensing Unit (cont'd)

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: 1-16

1. Functional Performance Test: Contractor shall verify operation of air handling unit in accordance with specification including the following:

a. Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

a. The following shall be verified when the [supply fan operating] [supply and return fans operating] mode is initiated:

(1) All dampers in normal position prior to fan start_____.

(2) All valves in normal position prior to fan start_____.

(3) System safeties allow start if safety conditions are met. ___

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position._____

(2) Return air damper open._____

(3) Relief air damper [at minimum position][closed]._____

(4) Chilled water control valve modulating to maintain space cooling temperature set point. Setpoint _____deg C(F) Actual _____deg C(F)

(5) Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller. _____

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. Setpoint _____deg C(F) Actual _____deg C(F) O/A damper position _____ percent Return Air Temperature_____deg C(F) Outside Air Temperature _____ deg C(F)

(2) Relief air damper modulates with outside air damper according to sequence of operation. Relief air damper position _____ percent

(3) Chilled water control valve modulating to maintain space cooling temperature set point. Setpoint _____deg C(F) Actual _____deg C(F) Return sensor overrides to normal operation.

d. Unoccupied mode of operation.
(1) Observe fan starts when space temperature calls for heating/cooling ____.
(2) All dampers in normal position. _____
(3) Verify low limit space temperature is maintained as specified in sequence of operation.
_____

Functional Performance Test Checklist (cont'd) - Single Zone Air Handling Unit

e. The following shall be verified when the [supply fan off][supply and return fans off] mode is initiated:

(1) All dampers in normal position._____

(2) All valves in normal position._____

(3) Fan de-energizes. _____

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point_____.

g. Verify safety shut down initiated by low temperature protection thermostat_____.

h. Verify occupancy schedule is programmed into time clock/UMCS_____.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: 2-16

1. Functional Performance Test: Contractor shall verify operation of air handling unit in accordance with specification including the following:

b. Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

c. The following shall be verified when the [supply fan operating] [supply and return fans operating] mode is initiated:

(1) All dampers in normal position prior to fan start_____.

(2) All valves in normal position prior to fan start_____.

(3) System safeties allow start if safety conditions are met. ___

d. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position._____

(2) Return air damper open._____

(3) Relief air damper [at minimum position][closed]._____

(4) Chilled water control valve modulating to maintain space cooling temperature set point. Setpoint _____deg C(F) Actual _____deg C(F)

(5) Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller. _____

c. Occupied mode of operation - economizer energized.

(4) Outside air damper modulated to maintain mixed air temperature set point. Setpoint _____deg C(F) Actual _____deg C(F) O/A damper position _____ percent Return Air Temperature_____deg C(F) Outside Air Temperature _____ deg C(F)

(5) Relief air damper modulates with outside air damper according to sequence of operation. Relief air damper position _____ percent

(6) Chilled water control valve modulating to maintain space cooling temperature set point. Setpoint _____deg C(F) Actual _____deg C(F) Return sensor overrides to normal operation.

d. Unoccupied mode of operation.
(1) Observe fan starts when space temperature calls for heating/cooling ____.
(2) All dampers in normal position. _____
(3) Verify low limit space temperature is maintained as specified in sequence of operation.
_____

Functional Performance Test Checklist (cont'd) - Single Zone Air Handling Unit

e. The following shall be verified when the [supply fan off][supply and return fans off] mode is initiated:

(1) All dampers in normal position._____

(2) All valves in normal position._____

(3) Fan de-energizes. _____

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point_____.

g. Verify safety shut down initiated by low temperature protection thermostat_____.

h. Verify occupancy schedule is programmed into time clock/UMCS_____.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist - Unit Heater

For Unit Heater: 1-16

The unit heater shall be checked during the functional performance test.

1. Functional Performance Test: Contractor shall demonstrate operation of the unit heater:

   a. Verify unit heater response to room temperature set point adjustment.
   _____
   b. Check heating mode inlet air temperature. _____ deg F
   c. Check heating mode outlet air temperature. _____ deg F
   d. Record manufacturer's submitted fan capacity _____cfm
   e. Calculate unit heater capacity using manufacturer's fan capacity and recorded temperatures and compare to design.
   f. Calculated_____BTU/hr. Design_____BTU/hr

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Contracting Officer's Representative _____

Using Agency's Representative _____

Functional Performance Test Checklist – Exhaust Fans

All exhaust fans shall be checked during the functional performance test. A separate functional performance test checklist shall be produced for each exhaust fan.

1. Functional Performance Test: Contractor shall demonstrate operation of the exhaust fan (s).

   a. Start exhaust fan. Verify that control system energizes exhaust fan start sequence _____.

   b. Stop exhaust fan. Verify that control system de-energizes exhaust fan per shut-down sequence. _____.

   c. Re-start exhaust fan five (5) minutes after shutdown. Verify exhaust fan re-start.

2. Verify exhaust fan running amps and phase – to – neutral voltage.

   Amperage: _____
   Phase- to-neutral voltage: _____

3. Record the following information:

   Fan CFM: _____

4. Unusual vibration, noise, etc.

5. Certification: We, the undersigned, have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____
Using Agency's Representative	_____

Functional Performance Test Checklist - HVAC Controls

For Multi V HVAC System: 1-16

All HVAC control systems shall undergo functional performance testing. Perform this test simultaneously with FPT for AHU or other controlled equipment.

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the Performance Verification Test (PVT) test for that system. Contractor to provide blank PVT test procedures previously done by the controls Contractor.

2. Verify interlock with UMCS system_____.

3. Verify all required I/O points function from the UMCS system_____.

4. Certification: We the undersigned have witnessed the Performance Verification Test and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Contractor's Officer's Representative _____

Using Agency's Representative _____

End of Appendix B –

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-- End of Section --

SECTION 23 09 23.13 20

BACNET DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

The Contractor shall furnish and install a complete Building Automation System (BAS)for the HVAC system at the project location including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. All components of the system shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2007. The BAS subcontractor shall program all BACnet devices installed at the project location with a BAS subcontractor owned BACnet Laptop Host Workstation. The BAS subcontractor's BACnet Host Workstation shall contain both the necessary software to fully program the BAS and also the graphical interface software (Schneider Electric/SmartStruxure or equal) with generic graphic displays to demonstrate that the BAS complies with all requirements of these specification and the drawing Sequence of Controls. Once the programming and the HVAC commissioning is completed and demonstrated to be operating satisfactorily, the BAS subcontractor shall make all BACnet points available to the Dyess HVAC Shop to import into the Dyess owned APOGEE/BACnet Host Workstation located in Building 8008. A BACnet/IP router shall be provided and connected to the Dyess AFB Ethernet LAN. No gateways shall be used nor required for the APOGEE/BACnet Host Workstation to communication to controllers furnished under this section. The BAS subcontractor shall coordinate network connection to the Dyess Ethernet LAN with 7CES and 7COMM after receiving an IP address from 7CES. Programming of the existing facility Router and the existing APOGEE/BACnet Host Workstation shall be by others. The BAS subcontractor shall dedicate and maintain the Laptop Host Workstation and all related BAS software for the full 1 year contractor's warranty period on the BAS installed in the facility.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D

(1998) Laboratory Methods of Testing Dampers for Rating

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ATA 878.1
(1999) ARCNET - Local Area Network: Token Ring

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135
(2004) BACnet

ASME INTERNATIONAL (ASME)

ASME B16.18
(2001; R 2005) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.22
(2001; R 2005) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26
(2006) Cast Copper Alloy Fittings for Flared Copper Tubes

ASME B16.34
(2004) Valves - Flanged, Threaded and Welding End

ASME B16.5
(2003) Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24 Metric/Inch Standard

ASME B31.1
(2004; Addenda 2005) Power Piping

ASME B40.100
(2006) Pressure Gauges and Gauge Attachments

ASME BPVC
(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Codes

ASTM INTERNATIONAL (ASTM)

ASTM A 126
(2004) Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM B 117
(2003) Operating Salt Spray (Fog) Apparatus

ASTM B 32
(2004) Solder Metal

ASTM B 75
(2002) Seamless Copper Tube

ASTM B 88
(2003) Seamless Copper Water Tube

ASTM B 88M
(2005) Seamless Copper Water Tube (Metric)

ASTM D 1238
(2004c) Melt Flow Rates of Thermoplastics by Extrusion Plastometer

ASTM D 1693
(2005) Environmental Stress-Cracking of Ethylene Plastics

ASTM D 635
(2006) Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

ASTM D 638

(2003) Tensile Properties of Plastics

ASTM D 792
(2000) Density and Specific Gravity (Relative Density) of Plastics by Displacement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13
(1993; R 2003) Standard Requirements for Instrument Transformers

IEEE C62.41
(1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

IEEE C62.45
(2002) Surge Testing for Equipment Connected to Low-Voltage (1000v and less)AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO/IEC 8802
(2000) Telecommunications and Information Exchange Between Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70
(2005; TIA 2005) National Electrical Code

NFPA 72
(2006) National Fire Alarm Code

NFPA 90A
(2002; Errata 2003; Errata 2005) Installation of Air Conditioning and Ventilating Systems

NATIONAL FLUID POWER ASSOCIATION (NFLPA)

NFPLA C12.10
(1997) Watthour Meters

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)
SMACNA HVAC
Duct Const Stds(1995; Addendum 1997, 2nd Ed) HVAC Duct Construction Standards - Metal and Flexible

UNDERWRITERS LABORATORIES (UL)

UL 1449
(2006) Surge Protective Devices

UL 506
(2000; Rev thru May 2006) Specialty Transformers

UL 508A
(2001) Standard for Industrial Control Panels

UL 916
(1998; Rev thru Mar 2006) Energy Management Equipment

1.2 DEFINITIONS

1.2.1 ANSI/ASHRAE Standard 135

ANSI/ASHRAE Standard 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, referred to as "BACnet". ASHRAE developed BACnet to provide a method for diverse building automation devices to communicate and share data over a network.

1.2.2 ARCNET

ANSI/ATA 878.1
- Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.

1.2.3 BACnet

Building Automation and Control Network (BACnet); the common name for the communication standard ASHRAE 135. The standard defines methods and protocol for cooperating building automation devices to communicate over a variety of LAN technologies.

1.2.4 BACnet/IP

An extension of BACnet, Annex J, defines this mechanism using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number. See also "BACnet Broadcast Management Device".

1.2.5 BACnet Internetwork

Two or more BACnet networks, possibly using different LAN technologies, connected with routers. In a BACnet internetwork, there exists only one message path between devices.

1.2.6 BACnet Network

One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.

1.2.7 BACnet Segment

One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.

1.2.8 BBMD

BACnet Broadcast Management Device (BBMD). A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Every IP subnetwork that is part of a BACnet/IP network must have only one BBMD. See also "BACnet/IP".

1.2.9 BAS

Building Automation Systems, including DDC (Direct Digital Controls) used for facility automation and energy management.

1.2.10 BAS Owner

The regional or local user responsible for managing all aspects of the BAS operation, including: network connections, workstation management, submittal review, technical support, control parameters, and daily operation. **The BAS Owner for this project is the USAF.**

1.2.11 BIBBs

BACnet Interoperability Building Blocks. A collection of BACnet services used to describe supported tasks. BIBBs are often described in terms of "A" (client) and "B" (server) devices. The “A” device uses data provided by the "B" device, or requests an action from the “B” device.

1.2.12 BI

BACnet International, formerly two organizations: the BACnet Manufacturers Association (BMA) and the BACnet Interest Group - North America (BIG-NA).

1.2.13 BI/BTL

BACnet International/BACnet Testing Laboratories (Formerly BMA/BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

1.2.14 Bridge

Network hardware that connects two or more network (or BACnet internetwork) segments at the physical and data link layers. A bridge may also filter messages.

1.2.15 Broadcast

A message sent to all devices on a network segment.

1.2.16 Device

Any control system component, usually a digital controller, that contains a BACnet Device Object and uses BACnet to communicate with other devices. See also "Digital Controller".

1.2.17 Device Object

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.

1.2.18 Device Profile

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE Standard 135-2004, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor(B-SS). Each device used in new construction is required to have a PICS statement listing BIBBs supported.

1.2.19 Digital Controller

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions. In most cases, synonymous with a BACnet device described in this specification. See also "Device".

1.2.20 Direct Digital Control (DDC)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.2.21 DDC System

A network of digital controllers, communication architecture, and user interfaces. A DDC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, and various other devices, components, and attributes.

1.2.22 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media.

1.2.23 Firmware

Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.

1.2.24 Gateway

Communication hardware connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. **The use of Gateways is strictly prohibited in this Section of Specifications.**

1.2.25 Half Router

A device that participates as one partner in a BACnet point-to-point (PTP) connection. Two half-routers in an active PTP connection combine to form a single router.

1.2.26 Hub

A common connection point for devices on a network.

1.2.27 Internet Protocol (IP, TCP/IP, UDP/IP)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media.

Two common Protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.2.28 Input/Output (I/O)

Physical inputs and outputs to and from a device, although the term sometimes describes software, or "virtual" I/O. See also "Points".

1.2.29 I/O Expansion Unit

An I/O expansion unit provides additional point capacity to a digital controller.

1.2.30 IP subnet

Internet protocol (IP) identifies individual devices with a 32-bit number divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00

1.2.31 Local-Area Network (LAN)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.2.32 MAC Address

Media Access Control address. The physical node address that identifies a device on a Local Area Network.

1.2.33 Master-Slave/Token-Passing (MS/TP)

ISO/IEC 8802(Part 3). One of the LAN options for BACnet. MSTP uses twisted-pair wiring for relatively low speed and low cost communication (up to 4,000 ft at 76.8K bps).

1.2.34 Native BACnet Device

A device that uses BACnet as its primary, if not only, method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.

1.2.35 Network

Communication technology for data communications. BACnet approved network types are BACnet over Internet Protocol (IP), Point to Point (PTP)Ethernet, ARCNET, and MS/TP.

1.2.36 Network Number

A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.

1.2.37 Object

The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.

1.2.38 Object Identifier

An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.

1.2.39 Object Properties

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.2.40 Peer-to-Peer

Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices.

1.2.41 Performance Verification Test (PVT)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.2.42 PID

Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.2.43 PICS

Protocol Implementation Conformance Statement (PICS), describing the BACnet capabilities of a device. See BACnet, Annex A for the standard format and content of a PICS statement.

1.2.44 Points

Physical and virtual inputs and outputs. See also "Input/Output".

1.2.45 PTP

Point-to-Point protocol connects individual BACnet devices or networks using serial connections like modem-to-modem links.

1.2.46 Repeater

A network component that connects two or more physical segments at the physical layer.

1.2.47 Router

A BACnet router is a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.

1.2.48 Stand-Alone Control

Refers to devices performing equipment-specific and small system control without communication to other devices or computers for physical I/O, excluding outside air and other common shared conditions. Devices are located near controlled equipment, with physical input and output points limited to 64 or less per device, except for complex individual equipment or systems. Failure of any single device will not cause other network devices to fail. BACnet "Smart" actuators (B-SA profile) and sensors (B-SS profile) communicating on a network with a parent device are exempt from stand-alone requirements.

1.3 BAS SUBCONTRACTOR SPECIAL REQUIREMENTS

All contract requirements of this section shall be accomplished directly by a first tier subcontractor. No work required shall be accomplished by a second tier subcontractor. The prime contractor shall hire the BAS subcontractor directly as opposed to being hired by the mechanical subcontractor.

1.4 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC DESCRIPTION

Provide new BACnet DDC system including associated equipment and accessories. All new devices are accessible using a Web browser interface and communicate using ASHRAE 135 BACnet communications without the use of gateways, unless gateways are shown on the design drawings and specifically requested by the Government. Where gateways are allowed, they must support ASHRAE 135, including all object properties and read-write services shown on Government approved interoperability schedules. Manufacturer's products, including design, materials, fabrication, assembly, inspection, and testing shall be in accordance with ASHRAE 135, ASME B31.1, and NFPA70, except where indicated otherwise.

1.4.1 Design Requirements

1.4.1.1 Control System Drawings Title Sheet

Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings.

1.4.1.2 List of I/O Points

Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), and point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria.

1.4.1.3 Control System Components List

Provide a complete list of control system components installed on this project. Include for each controller and device: control system schematic name, control system schematic designation, device description, manufacturer, and manufacturer part number. For sensors, include point name, sensor range, and operating

limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

1.4.1.4 Control System Schematics

Provide control system schematics. (Typical schematics for multiple identical equipment are not allowed unless each typical application is clearly identified, drawn, and well documented.) Include the following:

a. Location of each input and output device
b. Flow diagram for each piece of HVAC equipment
c. Name or symbol for each control system component, such as V-1 for a valve
d. Setpoints, with differential or proportional band values
e. Written sequence of operation for the HVAC equipment
f. Valve and Damper Schedules, with normal (power fail) position

1.4.1.5 HVAC Equipment Electrical Ladder Diagrams

Provide HVAC equipment electrical ladder diagrams. Indicate required electrical interlocks.

1.4.1.6 Component Wiring Diagrams

Provide a wiring diagram for each type of input device and output device. Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, actuators, sensors, and transmitters.

1.4.1.7 Terminal Strip Diagrams

Provide a diagram of each terminal strip. Indicate the terminal strip location, termination numbers, and associated point names.

1.4.1.8 BACnet Communication Architecture Schematic
Provide a schematic showing the project's entire BACnet communication network, including addressing used for LANs, LAN devices including routers and bridges, controllers, **APOGEE/BACnetHost Workstations, BAS subcontractor's Laptop Workstation,** and field interface devices. If applicable, show connection to existing networks.

1.5 SUBMITTALS

Submit detailed and annotated manufacturer's data, drawings, and specification sheets for each item listed, that clearly show compliance with the project specifications.

Government approval is required for all submittals.

Submit the following for approval:

1.5.1 Shop Drawings

Include the following in the project's control system drawing set:
Control system drawings title sheet
List of I/O Point

Control System Components List
Control system schematics
HVAC Equipment Electrical Ladder diagrams
Component wiring diagrams
Terminal strip diagrams
BACnet communication architecture schematic

1.5.2 Product Data

Direct Digital Controllers
Include BACnet PICS for each controller/device type, including smart sensors (B-SS) and smart actuators (B-SA)
Include BACnet and BAS subcontractor's Workstation display information; bi-directional communication ability; compliance with interoperability schedule; expansion capacity; handling of alarms, events, scheduling and trend data; and single device capability
BACnet Protocol Analyzer
Include capability to store and report data traffic on BACnet networks, measure bandwidth usage, filter information, and identify BACnet devices.
DDC Software
BACnet Operator Workstation
BACnet Operator Workstation DDC Software
Include BACnet PICS for BAS subcontractor's Workstation software.
Sensors and Input Hardware
Output Hardware
Surge and transient protection
Indicators
Air compressors
Refrigerated air dryers
Pneumatic tubing
Duct smoke detectors
Variable frequency (motor) drives

1.5.3 Design Data

Performance Verification Testing Plan
Pre-Performance Verification Testing Checklist

1.5.4 Test Reports

Performance Verification Testing Report

1.5.5 Certificates

Contractor's Qualifications

1.5.6 Manufacturer's Field Reports

Pre-PVT Checklist

1.5.7 Operation and Maintenance Data

BACnet Direct Digital Control Systems, Data Package 4

Controls System Operators Manuals, Data Package 4

VFD Service Manuals, Data Package 4 (Not applicable for this project.)

1.5.8 Closeout Submittals

Training documentation

1.6 QUALITY ASSURANCE

1.6.1 Standard Products

Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.

1.6.2 Delivery, Storage, and Handling

Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6.3 Operating Environment

Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.

1.6.4 Finish of New Equipment

New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be according to ASTM B 117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.

1.6.5 Verification of Dimensions

The contractor shall verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing work.

1.6.6 Contractor's Qualifications

Submit documentation certifying the controls Contractor performing the work has completed at least three DDC systems installations of a similar design to this project, and programmed similar sequences of operation for at least two years.

1.6.7 Modification of References

The advisory provisions in ASME B31.1 and NFPA 70 are mandatory. Substitute "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.6.8 Project Sequence

The control system work for this project shall proceed in the following order:
a. Submit and receive approval on the Shop Drawings, Product Data, and Certificates specified under the paragraph entitled "SUBMITTALS."
b. Perform the control system installation work, including all field check-outs and tuning.
c. Provide support to TAB personnel as specified under the paragraph "TEST AND BALANCE SUPPORT."
d. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "CONTROLS SYSTEM OPERATORS MANUALS."
e. Submit and receive approval of the Performance Verification Testing Plan and the Pre-PVT Checklist specified under the paragraph "PERFORMANCE VERIFICATION TESTING."
f. Perform the Performance Verification Testing.
g. Submit and receive approval on the PVT Report.
h. Submit and receive approval on the Training Documentation specified under the paragraph "INSTRUCTION TO GOVERNMENT PERSONNEL" and "VFD Service Support". Submit at least 30 days before training.
i. Deliver the final Controls System Operators Manuals and VFD Service Manuals.
j. Conduct the Phase I Training and VFD on-site/hands-on training.
k. Conduct the Phase II Training.
l. Submit and receive approval of Closeout Submittals.
m. **Provide support to the Dyess HVAC Shop during construction and during the 1 year warranty period by responding to their questions regarding their importation of BACnet points into the Dyess owned APOGEE/BACnet Host Workstation.**

PART 2 PRODUCTS

2.1 DDC SYSTEM

a. Provide a networked DDC system for stand-alone control in compliance with the latest revision of the ASHRAE 135 BACnet standard. Include all programming, objects, and services required to meet the sequence of control. Provide BACnet communications between the DDC system and native BACnet devices furnished with HVAC equipment to include plant equipment, boilers, chillers, and variable frequency drives. Devices provided shall be certified in the BACnet Testing Laboratories (BTL) Product Listing.

b. Furnish a BAS subcontractor owned Laptop Workstation to be used by the BAS subcontractor during construction. The Laptop Workstation and all Dyess related software shall be maintained on the Laptop for the complete 1 year warranty period. The Workstation shall be complete with interface software. It shall be capable of programming, configuring, and monitoring the digital controllers. It shall be used for testing and for demonstrating the BAS graphic creations, scheduling, alarming, and trending capability.

2.1.1 Direct Digital Controllers

Direct digital controllers shall be UL 916 rated.

2.1.1.1 I/O Point Limitation

The total number of I/O hardware points used by a single stand-alone digital controller, including I/O expansion units, shall not exceed 64, except for complex individual equipment or systems. Place I/O expansion units in the same cabinet as the digital controller.

2.1.1.2 Environmental Limits

Controllers shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.

2.1.1.3 Stand-Alone Control

Provide stand-alone digital controllers.

2.1.1.4 Internal Clock

Provide internal clocks for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.

2.1.1.5 Memory

Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, or by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history collected during normal operation shall not be lost during power outages less than 72 hours long.

2.1.1.6 Immunity to Power Fluctuations Controllers shall operate at 90% to 110% nominal voltage rating.

2.1.1.7 Transformer

The controller power supply shall be fused or current limiting and rated at 125% power consumption.

2.1.1.8 Wiring Terminations

Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.

2.1.1.9 Input and Output Interface

Provide hard-wired input and output interface for all controllers as follows:

a. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.

b. Binary Inputs: Binary inputs shall have a toggle switch and monitor on and off contacts from a "dry" remote device without external power, and external 5-24 VDC voltage inputs.

c. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.

d. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.
e. Binary Outputs: Binary outputs shall have a toggle switch and send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. For HVAC equipment and plant controllers, provide for manual overrides, either with three-position (on-off-auto) override switches and status lights, or with an adjacent operator display and interface. Where appropriate, provide a method to select normally open or normally closed operation.

f. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.

g. Tri-State Outputs: Tri-State outputs shall provide three-point floating control of terminal unit electronic actuators.

2.1.1.10 Digital Controller BACnet Internetwork

BACnet internetwork devices consisting of an intermediate gateway are not permissible.

2.1.1.11 Communications Ports

a. Direct-Connect Interface Ports: Provide at least one extra communication port at each local BACnet network for direct connecting a notebook computer or BACnet hand-held terminal so all network BACnet objects and properties may be viewed and edited by the operator.

b. Telecommunications Interface Port:
Provide one telecommunication port per building, permitting remote communication via point-to-point (PTP) protocol over telephone lines.

2.1.1.12 Modems

A modem shall not be required for communication between the APOGEE/BACnet Operator Workstation (B-OWS) and the DDC system.

2.1.1.13 BACnet Gateways

BACnet gateways shall not be required for commuications between the APOGEE/BACnet Operator Workstation (B-OWS) and the DDC system.

2.1.1.14 Digital Controller Cabinet

Provide each digital controller in a factory fabricated cabinet enclosure. Cabinets located indoors shall protect against dust and have a minimum **NEMA 4** rating, except where indicated otherwise. Cabinets located outdoors or in damp environments shall protect against all outdoor conditions and have a minimum NEMA 4 rating. Outdoor control panels and controllers must be able to withstand extreme ambient conditions, without malfunction or failure, whether or not the controlled equipment is running. If necessary, provide a thermostatically controlled panel heater in freezing locations, and an internal ventilating fan in locations exposed to direct sunlight. Cabinets shall have a hinged lockable door and an offset removable metal back plate, except controllers integral with terminal units, like those mounted on VAV boxes. Provide like-keyed locks for all hinged panels provided and a set of two keys at each panel, with one key inserted in the lock.

2.1.1.15 Main Power Switch and Receptacle

Provide each control cabinet with a main external power on/off switch located inside the cabinet. Also provide each cabinet with a separate 120 VAC duplex receptacle.

2.1.2 DDC Software

2.1.2.1 Programming

Provide programming to execute the sequence of operation indicated. Provide all programming and tools to configure and program all controllers. Provide programming routines in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation.

a. Graphic-based programming shall use a library of function blocks made from pre-programmed code designed for BAS control. Function blocks shall be assembled with interconnecting lines, depicting the control sequence in a flowchart.

b. Menu-based programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.

c. For line-by-line and text-based programming, declare variable types (local, global, real, integer, etc.) at the beginning of the program. Use descriptive comments frequently to describe the programming.

2.1.2.2 Parameter Modification

All writeable object properties, and all other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

2.1.2.3 Short Cycling Prevention

Provide setpoint differentials and minimum on/off times to prevent equipment short cycling.

2.1.2.4 Equipment Status Delay

Provide an adjustable delay from when equipment is commanded on or off and when the control program looks to the status input for confirmation.

2.1.2.5 Run Time Accumulation

Use the Elapsed Time Property to provide re-settable run time accumulation for each Binary Output Object connected to mechanical loads greater than 1 HP, electrical loads greater than 10 KW, or wherever else specified.

2.1.2.6 Timed Local Override

Provide an adjustable override time for each push of a timed local override button.

2.1.2.7 Time Synchronization

Provide time synchronization, including adjustments for leap years, daylight saving time, and operator time adjustments.

2.1.2.8 Scheduling

Provide operating schedules as indicated, with equipment assigned to groups. Changing the schedule of a group shall change the operating schedule of all equipment in the group. Groups shall be capable of operator creation, modification, and deletion. Provide capability to view and modify schedules in a seven-day week format. Provide capability to enter holiday and override schedules one full year at a time.

2.1.2.9 Object Property Override

Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out_Of_Service property of Objects shall be modifiable using BACnet's write property service. When documented, exceptions to these requirement are allowed for life, machine, and process safeties.

2.1.2.10 Alarms and Events

Alarms and events shall be capable of having programmed time delays and high-low limits. **When the APOGEE/BACnet Host Workstation is connected to the BACnet internetwork, alarms/events shall report to the computer or printer as defined by an authorized operator. Alarms/events shall also be stored within a device on the BACnet network until connected to a user interface device and retrieved.** Provide alarms/events **capability** in agreement with the point schedule, sequence of operation, and the BAS Owner. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition shown on schedules , communication to a device is lost, a device has failed, or a controller has lost its memory.

2.1.2.11 Trending

Provide BACnet trend services capable of trending all object present values set points, and other parameters indicated for trending on project schedules. Trends may be associated into groups, and a trend report may be set up for each group. Trends are stored within a device on the BACnet network, with operator selectable trend intervals from 10 seconds up to 60 minutes. The minimum number of consecutive trend values stored at one time shall be 100 per variable. When trend memory is full, the most recent data shall overwrite the oldest data. The operator workstation shall upload trends automatically upon reaching 3/4 of the device buffer limit (via Notification_Threshold property), by operator request, or by time schedule for archiving. Archived and real-time trend data shall be available for viewing numerically and graphically for at the workstation and connected notebook computers.

2.1.2.12 Device Diagnostics

Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The DDC system shall recognize and report a non-responsive controller.

2.1.2.13 Power Loss
Upon restoration of power, the DDC system shall perform an orderly restart and restoration of control.

2.1.3 APOGEE/BACnet Host Workstation

The APOGEE/BACnet Host Workstation at the HVAC Shop in Bldg 8008 will be capable of accessing all DDC system devices and communicate using the BACnet protocol. **The APOGEE/BACnet Host Workstation will** be capable of displaying, modifying, creating, archiving, and deleting (as applicable): all points, objects, object properties, programming, alarms, trends, messages, schedules, and reports **as permitted by the DDC System installed by the BAS subcontractor**.

The following is a general description of the existing government owned APOGEE/BACnet Host Workstation located at Bldg 8008 with Siemens Apogee Building Automation System software capable of monitoring and troubleshooting of the DDC system:
The government Host Workstation is a desktop personal computer with Microsoft Windows XP Professional operating system, RAM exceeding capability and speed required by the operating system and application software, hard drive capacity exceeding software and yearly archive requirements, 16X internal DVD+/-R/RW/CD-RW drive, and 4 USB 2.0 ports,

10/100 network interface card, [MS/TP card,] LCD monitor, sound card with speakers, 101 character keyboard, optical mouse, USB Hub with four USB 2.0 ports and connecting cable, ink jet printer with USB port and cable, 120-volt uninterruptible power supply, Microsoft Office bundled software, and Adobe Acrobat Writer.

2.1.4 BAS Subcontractor's Laptop Workstation

Furnish a notebook computer, complete with the project's installed DDC software, applications database, and graphics to fully troubleshoot and program the project's devices and their capabilities during construction and for the duration of the 1 year warranty period. The BAS subcontractor's Laptop Workstation shall have the ability to connect locally in real time, view all graphics, and fully troubleshoot, modify, and program all project devices. Provide the notebook computer with all necessary cables and interface hardware needed for setup and communication with the controllers and control system components.

At a minimum the notebook computer shall include: a Microsoft XP Professional operating system, processor with capability and speed required by application software, 40 giga-byte hard drive, 512 mega-byte RAM, 2 USB 2.0 ports, 10/100 network interface card, ARCnet card, MS/TP card, 15-inch display, keyboard, 3-hour battery with charger, 52X internal CD-RW drive with CD creator software, and Microsoft Office bundled software.

2.1.4.1 BAS Subcontractor's BACnet Laptop Workstation Software

The Laptop Workstation software shall permit complete monitoring, modification, and troubleshooting interface with the DDC system. The operator interface with the software shall be menu-driven with appropriate displays and menu commands to manipulate the DDC system's objects, point data, operating schedules, control routines, system configuration, trends, alarms, messages, graphics, and reports. Trends shall be capable of graphic display in real time, with variables plotted as functions of time. Each alarmed point shall be capable of displaying its alarm history, showing when it went into alarm, if and when it was acknowledged, and when it went out of alarm. The modification of DDC system parameters and object properties shall be accomplished with "fill in the blank" and/or "point and drag" methods. Modifications shall download to the appropriate controllers at the operator's request.

2.1.4.2 Graphics Software

Provide web-based system graphics viewable on browsers compatible with MS Internet Explorer 6.X or greater using an industry-standard file format such as HTML, BMP, JPEG, or GIF. Graphic displays shall have full-screen resolution when viewed on the workstation and notebook computers. Dynamic data on graphics pages shall refresh within 10 seconds using an Internet connection, or 30 seconds using a dial-up modem connection. Graphics viewing shall not require additional "plug-in" software like Java, Shockwave and Flash applications unless the software is readily available for free over the Internet, and certified for use with Navy Marine Corps Internet (NMCI) personal computers. The graphics shall show the present value and object name for each of the project's I/O points on at least one graphic page. Arrange point values and names on the graphic displays in their appropriate physical locations with respect to the floor plan or equipment graphic

displayed. Graphics shall allow the operator to monitor current status, view zone and equipment summaries, use point-and-click navigation between graphic pages, and edit setpoints and parameters directly from the screens. Items in alarm shall be displayed using a different color or other obvious visual indicator.

Provide graphics with the following:

a. Graphic Types: Provide at least one graphic display for each piece of HVAC equipment, building floor, and controlled zone. Indicate dynamic point values, operating statuses, alarm conditions, and control setpoints on each display. Provide summary pages where appropriate.

(1) Building Elevation: For buildings more than one story, provide an elevation view of the building with links to each of the building's floor plans. Simulate the building's architecture and include the building number and floor numbers. If possible, use an actual photograph of the building.

(2) Building Floor Plans: Provide a floor plan graphic for each of the building's floors and roof with dynamic display of space temperature and other important data. If used, indicate and provide links to sub-plan areas. If possible, use the project's electronic drawing files for the graphic backgrounds. Provide clear names for important areas, such as "Main Conference Room." Include room names and numbers where applicable. Include features such as stairwells, elevators, and main entrances. Where applicable, include the mechanical room, HVAC equipment, and control component locations, with corresponding links to the equipment graphics.

(3) Sub-plan Areas: Where a building's floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. Provide same level of detail requested in building floor plan section above.

(4) HVAC Equipment: Provide a graphic display for each piece of HVAC equipment, such as a fan coil unit, VAV terminal, or air handling unit. Equipment shall be represented by a two or three-dimensional drawing. Where multiple pieces of equipment combine to form a system, such as a central chiller plant or central heating plant, provide one graphic to depict the entire plant. Indicate the equipment, piping, ductwork, dampers, and control valves in the installed location. Include labels for equipment, piping, ductwork, dampers, and control valves. Show the direction of air and water flow. Include dynamic display of applicable object data with clear names in appropriate locations.

(5) Sequence of Operation: Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment. Provide a link to the sequence of operation displays on their respective equipment graphics. Include dynamic real-time data within the text for setpoints and variables.

b. Graphic Title: Provide a prominent, descriptive title on each graphic page.

c. Dynamic Update: When the workstation is on-line, all graphic I/O object values shall update with change-of-value services, or by operator selected discrete intervals.

d. Graphic Linking: Provide forward and backward linking between floor plans, sub-plans, and equipment.

e. Graphic Editing: Provide installed software to create, modify, and delete the DDC graphics. Include the ability to store graphic symbols in a symbol directory and import these symbols into the graphics.

f. Dynamic Point Editing: Provide full editing capability for deleting, adding, and modifying dynamic points on the graphics

2.2 SENSORS AND INPUT HARDWARE

Coordinate sensor types with the BAS Owner to keep them consistent with existing installations.

2.2.1 Field-Installed Temperature Sensors

Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.

2.2.1.1 Thermistors

Precision thermistors may be used in applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degree F cumulative. A/D conversion resolution error shall be kept to 0.1 degree F. Total error for a thermistor circuit shall not exceed 0.5 degree F.

2.2.1.2 Resistance Temperature Detectors (RTDs)

Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degree F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degree F.

2.2.1.3 Temperature Sensor Details

a. Room Type: Provide the sensing element components within a decorative protective cover suitable for surrounding decor. [Provide room temperature sensors with timed override button, setpoint adjustment lever, digital Temperature display.] [Provide a communication port or 802.11x wireless support for a portable operator interface like a notebook computer or PDA.]

b. Duct Probe Type: Ensure the probe is long enough to properly sense the air stream temperature.

c. Duct Averaging Type: Continuous averaging sensors shall be one foot in length for each 4 square feet of duct cross-sectional area, and a minimum length of 6 ft.

d. Pipe Immersion Type: Provide minimum three-inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior.

e. Outside Air Type: Provide the sensing element on the building's north side with a protective weather shade that positions the sensor approximately 3 inches off the wall surface, does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain.

2.2.2 Transmitters

Provide transmitters with 4 to 20 mA or 0 to 10 VDC linear output scaled to the sensed input. Transmitters shall be matched to the respective sensor, factory calibrated, and sealed. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions. The total transmitter error shall not exceed

0.1 percent at any point across the measured span. Supply voltage shall be 12 to 24 volts AC or DC. Transmitters shall have non-interactive offset and span adjustments. For temperature sensing, transmitter drift shall not exceed 0.03 degrees F a year.

2.2.2.1 Relative Humidity Transmitters

Provide transmitters with an accuracy equal to plus or minus 3 percent from 0 to 90% scale, and less than one percent drift per year. Sensing elements shall be the polymer type.

2.2.2.2 Pressure Transmitters

Provide transmitters integral with the pressure transducer.

2.2.3 Current Transducers

Provide current transducers to monitor motor amperage, unless current switches are shown on design drawings or point tables.

2.2.4 Pneumatic to Electric Transducers

Pneumatic to electronic transducers shall convert a 0 to 20 psig signal to a proportional 4 to 20 mA or 0 to 10 VDC signal (operator scalable). Supply voltage shall be 24 VDC. Accuracy and linearity shall be 1.0 percent or better.

2.2.5 Air Quality Sensors

Provide power supply for each sensor.

2.2.5.1 CO2 Sensors

Provide photo-acoustic type CO2 sensors with integral transducers and linear output. The devices shall read CO2 concentrations between 0 and 2000 ppm with full scale accuracy of at least plus or minus 100 ppm.

2.2.5.2 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor shall monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor shall automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

2.2.6 Input Switches

2.2.6.1 Timed Local Overrides

Provide buttons or switches to override the DDC occupancy schedule programming for each major building zone during unoccupied periods, and to return HVAC equipment to the occupied mode. This requirement is waived for zones clearly intended for 24 hour continuous operation.

2.2.7 Freeze Protection Thermostats

Provide special purpose thermostats with flexible capillary elements 20 feet minimum length for coil face areas up to 40 square feet. Provide longer elements for larger coils at 1-foot of element for every 4 square feet of coil face area, or provide additional thermostats. Provide switch contacts rated for the respective motor starter's control circuit voltage. Include auxiliary contacts for the switch's status condition. A freezing condition at any 18-inch increment along the sensing element's length shall activate the switch. The thermostat shall be equipped with a manual push-button reset switch so that when tripped, the thermostat requires manual resetting before the HVAC equipment can restart.

2.2.8 Air Flow Measurement Stations

Air flow measurement stations shall have an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements shall be the RTD or thermistor type, traversing the ducted air in at least two directions. The air flow pressure drop across the station shall not exceed 0.08 inch water gage at a velocity of 2,000 fpm. The station shall be suitable for air flows up to 5,000 fpm, and a temperature range of 40 to 120 degrees F. The station's measurement accuracy over the range of 125 to 2,500 fpm shall be plus or minus 3 percent of the measured velocity. Station transmitters shall provide a linear, temperature-compensated 4 to 20 mA or 0 to 10 VDC output. The output shall be capable of being accurately converted to a corresponding air flow rate in cubic feet per minute. Transmitters shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the measurement.

2.2.9 Energy Metering

2.2.9.1 Electric Meters

Provide kilowatt-hour (kWh) meter(s) where shown in accordance with NFPLA C12.10, suitable for the intended voltage, phases, and wye/delta configuration, with three current transformers and an output signal compatible with the DDC system. The meter shall have a box-mounted socket and an automatic circuit-closing bypass. Provide the meter with at least four pointer-type kWh registers, provisions for pulse initiation, and universal Class 2 indicating maximum kW demand register, sweep pointer indicating type, and a 15 minute interval. The meter accuracy shall be within plus or minus one percent of the actual kWh. Provide the correct multiplier on the meter face. Provide the current transformers in accordance with IEEE C57.13, with 600-volt insulation, and rated for metering with voltage, IL, momentary, and burden ratings coordinated with the ratings of corresponding meters. Provide butyl-molded donut or window type transformers mounted on a bracket to allow secondary cables to connect to the transformer bushings. Provide wiring identification of the current transformer secondary feeders to permit field measurements to be taken with hook-on ammeters.

2.2.9.2 Steam Meters

Steam meters where shown. Meters shall be the vortex type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal compatible with the DDC system.

2.3 OUTPUT HARDWARE

2.3.1 Control Dampers

Control dampers shall conform to VSMACNA HVAC Duct Construction Standards.

a. For field-installed dampers, a single damper section shall have blades no longer than 1220 mm 48 inches and no higher than 1830 mm 72 inches. The maximum damper blade width shall be 203 mm 8 inches. Larger sized dampers shall be built using a combination of sections.

b. Dampers shall be galvanized steel construction, unless indicated otherwise. Frames shall be at least 2 inches wide. Flat blades shall have edges folded for rigidity. Blades shall be provided with compressible gasket seals along the full length of the blades to prevent air leakage when closed. The damper frames shall be provided with jamb seals to minimize air leakage. Seals shall be suitable for an operating temperature range of minus 40 degrees C to 93 degrees C 40 degrees F to 200 degrees F. The leakage rate of each damper when full-closed shall be no more than 20 cfm per square foot of damper face area at 996 Pa 4 inches water gage static pressure. Dampers shall be rated for not less than 10 m/s 2000 fpm air velocity. Damper axles shall be 13 mm minimum 0.5 inches diameter plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. The pressure drop through each damper when full-open shall not exceed 10 Pa gage at 5 m/s 0.04 inches water gage at 1000 fpm face velocity. Damper leakage rates and pressure drops shall be tested in accordance with AMCA 500.

c. The damper operating linkages external to dampers (such as crank arms, connecting rods, and other hardware that transmits motion from the damper actuators to the dampers) shall be adjustable, and capable of withstanding a load equal to twice the maximum required damper-operating force. Linkages shall be brass, bronze, galvanized steel, or stainless steel.

2.3.2 Control Valves

2.3.2.1 Valve Assembly

Valve bodies shall be designed for 125 psig minimum working pressure or 150 percent of the operating pressure, whichever is greater. Valve stems shall be Type 316 stainless steel. Valve leakage ratings shall be 0.01 percent of rated Cv value. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall meet the requirements of ASME B16.5. Cast iron valve components shall meet the requirements of ASTM A 126 Class B or C.

2.3.2.2 Butterfly Valves

Butterfly valves shall be the threaded lug type suitable for dead-end service and for modulation to the fully-closed position, with stainless steel shafts supported by bearings, non-corrosive discs geometrically interlocked with or bolted to the shaft (no pins), and EPDM seats suitable for temperatures from minus 29 degrees C to plus 121 degrees C minus 20 degrees F to plus 250 degrees F. Valves shall have a means of manual operation independent of the actuator.

2.3.2.3 Two-Way Valves

Two-way modulating valves shall have an equal percentage characteristic.

2.3.2.4 Three-Way Valves

Three-way valves shall have an equal percentage characteristic.

2.3.2.5 Valves for Chilled Water, Condenser Water, and Glycol Fluid Service

a. Bodies for valves 40 mm 1 1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for
50 mm 2 inch valves shall have threaded connections. Bodies for valves from
65 to 80 mm 2 1/2 to 3 inches shall have flanged connections.

b. Internal valve trim shall be brass or bronze, except that valve stems shall be stainless steel.

c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

d. Valves 100 mm 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.6 Valves for Hot Water Service

Valves for hot water service below 121 degrees C 250 Degrees F:

a. Bodies for valves 40 mm 1 1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm
2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 50 mm 2 inch valves shall have threaded connections. Bodies for valves from 65 to 80 mm 2 1/2 to 3 inches shall have flanged connections.

b. Internal trim (including seats, seat rings, modulation plugs, valve stems, and springs) of valves controlling water above 99 degrees C 210 degrees F shall be Type 316 stainless steel.

c. Internal trim for valves controlling water 99 degrees C 210 degrees F
or less shall be brass or bronze. Valve stems shall be Type 316 stainless steel.

d. Non-metallic parts of hot water control valves shall be suitable for a minimum continuous operating temperature of 121 degrees C or 28 degrees C
250 degrees F or 50 degrees F above the system design temperature, whichever is higher.

e. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.
f. Valves 100 mm 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.7 Valves for High Temperature Hot Water Service Valves for hot water service 121 degrees C above 250 Degrees F:

a. Valve bodies shall conform to ASME B16.34 Class 300. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 25 mm 1 inch and larger. Valves smaller than 25 mm 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE).

b. Internal valve trim shall be Type 316 stainless steel.

c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

2.3.2.8 Valves for Steam Service

The entire body for valves 40 mm 1 1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm 2 to 3 inches inclusive shall be of brass, bronze, or carbon steel. Bodies for valves 100 mm 4 inches and larger shall be carbon steel. Bodies for 50 mm 2 inch valves shall have threaded connections. Bodies for valves 65 mm
2 1/2 inches and larger shall have flanged connections. Steam valves shall be sized for 15 psig inlet steam pressure with a maximum 13 psi differential through the valve at rated flow, except where indicated otherwise. Internal valve trim shall be Type 316 stainless steel.

2.3.3 Actuators

Provide direct-drive electric actuators for all control applications, except where indicated otherwise.

2.3.3.1 Electric Actuators

Each actuator shall deliver the torque required for continuous uniform motion and shall have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators shall function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds. Provide two-position actuators of single direction, spring return, or reversing type. Provide modulating actuators capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators shall be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Thermal type actuators may only be used on terminal fan coil units, terminal VAV units, convectors, and unit heaters. Spring return actuators shall be provided on all control dampers and all control valves except terminal fan coil units, terminal VAV units, convectors, and unit heaters; unless indicated otherwise. Each actuator shall have distinct markings indicating the full-open and full-closed position, and the points in-between.

2.3.3.2 Pneumatic Actuators

Provide piston or diaphragm type actuators

2.3.4 Output Signal Conversion

2.3.4.1 Electronic-to-Pneumatic Transducers

Electronic to pneumatic transducers shall convert a 4 to 20 mA or 0 to 10 VDC digital controller output signal to a proportional 0 to 20 psig pressure signal (operator scalable). Accuracy and linearity shall be 1.0 percent or better. Transducers shall have feedback circuit that converts the pneumatic signal to a proportional 4 to 20 mA or 0 to 10 VDC signal.

2.3.5 Output Switches

2.3.5.1 Control Relays

Field installed and DDC panel relays shall be double pole, double throw, UL listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.4 ELECTRICAL POWER AND DISTRIBUTION

2.4.1 Transformers

Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.

2.4.2 Surge and Transient Protection

Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.

2.4.2.1 Power Line Surge Protection

Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with
UL 1449, have a fault indicating light, and conform to the following:

a. The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.

b. The device shall react within 5 nanoseconds and automatically reset.

c. The voltage protection threshold, line to neutral, shall be no more than 211 volts.

d. The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.

e. The primary suppression system components shall be pure silicon avalanche diodes.

f. The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.

g. The device shall have an indication light to indicate the protection components are functioning.

h. All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.

i. The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.

j. The device shall comply with IEEE C62.41, Class "B" requirements and be tested according to IEEE C62.45.

k. The device shall be capable of operating between -20 degrees F and +122 degrees F.

2.4.2.2 Telephone and Communication Line Surge Protection
Provide surge and transient protection for DDC controllers and DDC network related devices connected to phone and network communication lines, in accordance with the following:

a. The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges.

b. The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.

c. The device shall be installed at the distance recommended by its manufacturer.

2.4.2.3 Controller Input/Output Protection

Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

2.4.3 Wiring

Provide complete electrical wiring for the DDC System, including wiring to transformer primaries. Unless indicated otherwise, provide all normally visible or otherwise exposed wiring in conduit. Where conduit is required, control circuit wiring shall not run in the same conduit as power wiring over 100 volts. Circuits operating at more than 100 volts shall be in accordance with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Run all circuits over 100 volts in conduit, metallic tubing, covered metal raceways, or armored cable. Use plenum-rated cable for circuits under 100 volts in enclosed spaces. Examples of these spaces include HVAC plenums, within walls, above suspended ceilings, in attics, and within ductwork.

2.4.3.1 Power Wiring

The following requirements are for field-installed wiring:

a. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.

b. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.

2.4.3.2 Analog Signal Wiring

Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

2.5 FIRE PROTECTION DEVICES

2.5.1 Duct Smoke Detectors

Provide duct smoke detectors in HVAC ducts in accordance with NFPA 72 and NFPA 90A, except as indicated otherwise. Provide UL listed or FM approved detectors, designed specifically for duct installation.

Furnish detectors under Section 28 31 74.00 20 INTERIOR FIRE DETECTION AND ALARM SYSTEM and install under this section. Connect new detectors to the building fire alarm panel.

Provide ionization type detectors. Detectors shall detect both visible and invisible particles of combustion, and shall not be susceptible to undesired operation by changes to relative humidity. Provide each detector with an approved duct housing mounted exterior to the duct, and an integral perforated sampling tube extending across the width of the duct. The detector housing shall have indicator lamps that light when the detector is powered and when the detector is activated. Each detector shall have an integral test port, test switch, and remote keyed test device. Connect new detectors to the building's fire alarm control panel. Provide control and power modules required for the operation of the detectors in their own new control unit. A ground fault, break, or open condition in the electrical circuitry to any detector or its control or power unit shall cause activation of a trouble signal at the building fire alarm panel. Electrical supervision of wiring used exclusively for air-handling unit shutdown is not required, provided a break in the wiring would cause shutdown of the associated unit. Equipment and devices shall be compatible and operable in all respects with, and shall in no way impair the reliability or operational functions of, the fire alarm system. Provide descriptive zone labels at the fire alarm panel indicating which new air-handling unit detectors they serve and their location. Label zones modified in order to accomplish the work.

2.6 INDICATORS

2.6.1 Thermometers

Provide bi-metal type thermometers at locations shown. Thermometers shall have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy shall be plus or minus 2 percent of the scale range.

2.6.2 Pressure Gauges for Piping Systems (NOT APPLICABLE FOR THIS BUILDING 7237 PROJECT.)

Provide pipe-mounted pressure gauges at the locations shown. Gauges shall conform to ASME B40.100 and have a 4-inch diameter dial and shutoff cock. Provide gauges in steam piping with a pressure snubber pigtail fitting. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy shall be plus or minus 2 percent of the scale range.

2.6.3 Pressure Gauges for Pneumatic Controls

Provide a pressure gauge at each pneumatic control input and output. Gauges shall have a 2-inch diameter face and a 0 to 30 psi scale with 1 psi graduations.

2.7 PNEUMATIC POWER SUPPLY AND TUBING

2.7.1 Air Compressors

Air compressors for pneumatic control systems shall be the tank-mounted, electric motor driven, air cooled, reciprocating type with integral single motor and compressor, tank, controller, pressure switch, belt guard, pressure relief valve, and automatic moisture drain valve. Compressor piston speeds shall not exceed 450 fpm. Provide compressors with a dry-type combination intake air filter and silencer with baked enamel steel housing. The filter shall be 99 percent efficient at 10 microns. The pressure switch shall start the compressor at 70 psig and stop the compressor at 90 psig. The relief valve shall be set for 10 to 25 psig above the control switch cut-off pressure. Provide compressor capacity suitable for not more than a 33 percent run time, at full system control load. Compressors shall have a maintaining type starter, and shall automatically restart after a power outage. Motors 0.5 hp and larger shall be three-phase.

2.7.1.1 Compressed Air Tank

Provide a steel tank constructed and labeled in agreement with ASME BPVC for 125 psig maximum working pressure. Size the tank for the compressor run time specified above. Provide drain valve and piping routing the drainage to a floor sink or other safe and visible drainage location.

2.7.2 Refrigerated Air Dryers

Provide each air compressor tank with a refrigerant air dryer sized for continuous operation, and capable of reducing the compressed air dew point temperature, at 20 psig output pressure, to 30 degrees F, at an average tank pressure of 80 psig and an ambient air temperature between 55 and 95 degrees F. Provide each dryer with an automatic condensate drain trap with manual override feature. Provide the dryer suction line with a refrigerant pressure gauge. Locate each dryer in the air piping between the tank and the pressure-reducing station.

2.7.3 Compressed Air Discharge Filters

Provide air compressors with a dry type discharge filter, 99 percent efficient at removing oil and solid particles at 0.03 microns, with baked enamel steel housing and manual drain valve. Provide visual indicator to show when the filter element should be changed.

2.7.4 Air Pressure-Reducing Stations

Provide air compressors with a pressure-reducing valve (PRV) with a field adjustable range of 0 to 50 psig discharge pressure, at an inlet pressure of 70 to 90 psig. Provide a factory-set pressure relief valve downstream of the PRV to relieve over-pressure. Provide a pressure gage upstream of the PRV with range of 0 to 100 psig and downstream of the PRV with range of 0 to 30 psig. For two-pressure control systems, provide an additional PRV and downstream pressure gage.

2.7.5 In-line Filters

Provide a disposable type in-line filter in the incoming pneumatic main at each pneumatic control panel. The filter shall be capable of eliminating 99.99 percent of all liquid or solid contaminants 0.1 micron or larger. Provide the filter with fittings that allow easy removal/replacement.

2.7.6 Pneumatic Tubing

2.7.6.1 Copper Tubing

Provide ASTM B 75 or ASTM B 88M ASTM B 88 rated tubing. Tubing 0.64 mm 0.375 inch outside diameter and larger shall have minimum wall thickness equal to
ASTM B 88M ASTM B 88, Type M. Tubing less than 10 mm 0.375 inch outside diameter shall have minimum wall thickness of 0.64 mm 0.025 inch. Exposed tubing and tubing for working pressures greater than 30 psig shall be hard copper. Fittings shall be ASME B16.18 or ASME B16.22 solder type using ASTM B 32 95-5 tin-antimony solder, or ASME B16.26 compression type.

2.7.6.2 Polyethylene Tubing

Polyethylene tubing may only be used in systems with working pressure of 30 psig or less. Provide flame-resistant, multiple polyethylene tubing in flame-resistant protective sheath with mylar barrier, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Single, unsheathed, flame-resistant polyethylene tubing may be used where concealed in walls or above ceilings and within control panels. Do not provide polyethylene tubing for [systems indicated as critical and] smoke removal systems. Provide compression or brass barbed push-on type fittings. Extruded seamless polyethylene tubing shall conform to the following:

a. Minimum Burst Pressure Requirements: 100 psig 690 kPA at 75 degrees F 24 degrees C to 25 psig 172 kPa at 150 degrees F 66 degrees.

b. Stress Crack Resistance: ASTM D 1693, 200 hours minimum.

c. Tensile Strength (Minimum): ASTM D 638,7583 kPa 1100 psi.

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d. Flow Rate (Average): ASTM D 1238, 0.30 decigram per minute.

e. Density (Average): ASTM D 792, 920 kg/m3 57.5 pounds per cubic feet

f. Burn rate: ASTM D 635

2.8 VARIABLE FREQUENCY (MOTOR) DRIVES (NOT APPLICABLE FOR THIS BUILDING 7237 PROJECT.)

Provide variable frequency drives (VFDs) as indicated. VFDs shall convert 240 or 460 volt (+/- 10%), three phase, 60 hertz (+/- 2Hz), utility grade power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5% to 105% of base speed. VFDs shall be UL listed as delivered to the end user. The VFD shall meet the requirements specified in the most current National Electrical Code. Each VFD shall also meet the following:

a. The VFD shall use sine coded Pulse Width Modulation (PWM) technology. PWM calculations shall be performed by the VFD microprocessor.

b. The VFD shall be capable of automatic control by a remote 4-20 mA signal, by network command, or manually by the VFD control panel.

2.8.1 VFD Quality Assurance

VFDs shall be the manufacturer's current standard production unit with at least 10 identical units successfully operating in the field.

2.8.2 VFD Service Support

a. Warranty: Provide the VFDs with a minimum 24-month full parts and labor warranty. The warranty shall start when the contract's HVAC system is accepted by the Government. Include warranty documentation, dates, and contact information with the VFD on-site service manuals.

b. VFD Service Manuals: Provide the VFDs with all necessary installation, operation, maintenance, troubleshooting, service, and repair manuals in English including related factory technical bulletins. Provide the documents factory bound, in sturdy 3-ring binders, or hard bound covers. Provide a title sheet on the outside of each binder indicating the project title, project location, installing contractor, contract number, and the VFD manufacturer, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. The documentation provided shall be specifically applicable to this project, shall be annotated to reflect the actual project conditions, and shall provide a complete and concise depiction of the installed work. [Provide a storage cabinet on or near the VFD large enough to hold all of the documentation. Have the cabinet's proposed installation site approved in advance by the Contracting Officer. Prominently label the cabinet "VFD OPERATION AND MAINTENANCE MANUALS." Clearly label each manual with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE".

c. Technical Support: Provide the VFDs with manufacturer's technical telephone support in English, readily available during normal working hours, and free of charge for the life of the equipment.

d. Initial Start-Up: Provide the VFDs with factory-trained personnel for the on-site start-up of the HVAC equipment and associated VFD. The personnel shall be competent in the complete start-up, operation, and repair of the particular model VFD installed. The factory start-up representative shall perform the factory's complete recommended start-up procedures and check-out tests on the VFD. Include a copy of the start-up test documentation with the VFD on-site service manuals.

e. Provide the VFDs with on-site/hands-on training for the user and maintenance personnel. Provide a capable and qualified instructor with minimum two years field experience with the operation and maintenance of similar VFDs. The training shall occur during normal working hours and last not less than 2 hours. Coordinate the training time with the Contracting Officer and the end user. The VFD service manuals shall be

used during the training. The contractor shall ensure the manuals are on-site before the start of training. The training shall cover all operational aspects of the VFD.

2.8.3 VFD Features

VFDs shall have the following features:

a. A local operator control keypad capable of:

(1) Remote/Local operator selection with password access.
(2) Run/Stop and manual speed commands.
(3) All programming functions.
(4) Scrolling through all display functions.

b. Digital display capable of indicating:

(1) VFD status.
(2) Frequency.
(3) Motor RPM.
(4) Phase current.
(5) Fault diagnostics in descriptive text.
(6) All programmed parameters.

c. Standard PI loop controller with input terminal for controlled variable and parameter settings.

d. User interface terminals for remote control of VFD speed, speed feedback, and an isolated form C SPDT relay, which energizes on a drive fault condition.

e. An isolated form C SPDT auxiliary relay which energizes on a run command.

f. A metal NEMA 1 enclosure for indoors, NEMA 4 with heater for outdoors.

g. An adjustable carrier frequency with 16 KHz minimum upper limit.

h. A built in or external line reactor with 3% minimum impedance to protect the VFDs DC buss capacitors and rectifier section diodes.

2.8.4 Programmable Parameters

VFDs shall include the following operator programmable parameters:

a. Upper and lower limit frequency.

b. Acceleration and Deceleration rate.

c. Variable torque volts per Hertz curve.

d. Starting voltage level.

e. Starting frequency level.

f. Display speed scaling.

g. Enable/disable auto-restart feature.

h. Enable/disable soft stall feature.

i. Motor overload level.

j. Motor stall level.

k. Jump frequency and hysteresis band.

l. PWM carrier frequency.

2.8.5 Protective Features

VFDs shall have the following protective features:

a. An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.

b. An electronic adjustable soft stall feature, allowing the VFD to lower the frequency to a point where the motor will not exceed the full-load amperage when an overload condition exists at the requested frequency. The VFD will automatically return to the requested frequency when load conditions permit.

c. A separate electronic stall at 110% VFD rated current, and a separate hardware trip at 190% current.

d. Ground fault protection that protects the output cables and motor from grounds during both starting and continuous running conditions.

e. The ability to restart after the following faults:

(1) Overcurrent (drive or motor).
(2) Power outage.
(3) Phase loss.
(4) Over voltage/Under voltage.

f. The ability shut down if inadvertently started into a rotating load without damaging the VFD or the motor.

g. The ability to keep a log of a minimum of four previous fault conditions, indicating the fault type and time of occurrence in descriptive text.

h. The ability to sustain 110% rated current for 60 sec.

i. The ability to shutdown safely or protect against and record the following fault conditions:

(1) Over current (and an indication if the over current was during acceleration, deceleration, or running).

(2) Over current internal to the drive.

(3) Motor overload at start-up.

(4) Over voltage from utility power.

(5) Motor running overload.
(6) Over voltage during deceleration.

(7) VFD over heat.

(8) Load end ground fault.

(9) Abnormal parameters or data in VFD EEPROM.

2.8.6 Minimum Operating Conditions
VFDs shall be designed and constructed to operate within the following service conditions:

a. Ambient Temperature Range, 0 to 120 deg. F.

b. Non-condensing relative humidity to 90%.

2.8.7 Additional Features

Provide VFDs with the following additional features:

a. BACnet communication interface port

b. RFI/EMI filters

c. Manual bypass circuit and switch integral to the drive to allow drive bypass and operation at 100% speed. Motor overload and short circuit protective features shall remain in use during the bypass mode.

PART 3 EXECUTION

3.1 INSTALLATION

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1 BACnet Naming and Addressing

Coordinate with the BAS Owner and provide unique naming and addressing for BACnet networks and devices.

a. MAC Address

Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For ARCNET or MS/TP, assign from 00 to 64.

b. Network Numbering

Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.

c. Device Object Identifier Property Number

Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.

d. Device Object Name Property Text

The Device Object Name property field shall support 32 minimum printable characters. Assign unique Device "Object_Name" property names with plain-English descriptive names for each device
For example, the Device Object Name that for the device controlling the chiller plant at Building 3408 would be:

Device Object_Name = CW System B3408
A Device Object Name for a VAV box controller might be:
Device Object_Name = VAV BOX25

e. Object Name Property Text (Other than Device Objects)

The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

f. Object Identifier Property Number (Other than Device Objects)

Assign Object Identifier property numbers according to design drawings or tables if provided. If not provided, Object Identifier property numbers may be assigned at the Contractor's discretion but must be approved by the Government. In this case they must be documented and unique for like object types within the device.

3.1.2 Minimum BACnet Object Requirements

a. Use of Standard BACnet Objects

For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service: all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.

b. BACnet Object Description Property

The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.

c. Analog Input, Output, and Value Objects

Support and provide Description and/or Device_Type text strings matching signal type and engineering units shown on the points list.

d. Binary Input, Output, and Value Objects

Support and provide Inactive_Text and Active_Text property descriptions matching conditions shown on the points list.

e. Calendar Object

For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. All operators may view Calendar Objects; authorized operators may make modifications from a workstation. Enable the writeable Date List property and support all calendar entry data types.

f. Schedule Object

Use Schedule Objects for all building system scheduling. All operators may view schedule entries; authorized operators may modify schedules from a workstation.

g. Loop Object or Equal

Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint, Proportional Constant, Integral Constant, and Derivative Constant using BACnet read/write services.

3.1.3 Minimum BACnet Service Requirements

a. Command Priorities

Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below. If the sequence of operation requires a different priority, obtain approval from the Contracting Officer.

Priority Level	Application
1	Manual-Life Safety
2	Automatic-Life Safety
3	(User Defined)
4	(User Defined)
5	Critical Equipment Control
6	Minimum On/Off
7	(User Defined)
8	Manual Operator
9	(User Defined)
10	(User Defined)
11	Load Shedding
12	(User Defined)
13	(User Defined)
14	(User Defined)
15	(User Defined)
16	(User Defined)

b. Alarming

(1) Alarm Priorities - Coordinate alarm and event notification with the BAS Owner.

(2) Notification Class - Enable writeable Priority, Ack Required, and Recipient List properties of Notification Class objects.

(3) Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

c. Updating Displayed Property Values

Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

3.1.4 Local Area Networks

Obtain Government approval before connecting new networks with existing networks. Network numbers and device instance numbers shall remain unique when joining networks. Do not change existing network addressing without Government approval. See also "BACnet Naming and Addressing".

3.1.5 BACnet Routers, Bridges, and Switches

Provide the quantity of BACnet routers, bridges, and switches necessary for communications shown on the BACnet Communication Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet internetwork communicating across an IP network. Configure each BACnet device and bridge, router, or switch to communicate on its network segment.

3.1.6 Wiring Criteria

a. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.

b. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.

c. Provide circuit and wiring protection required by NFPA 70

d. Run all wiring located inside mechanical rooms in conduit.

e. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.

f. Input/output identification: Permanently label each field-installed wire, cable, and pneumatic tube at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Number each pneumatic tube every six feet. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.

g. For controller power, provide new 120 VAC circuits, with ground. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.

h. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.

i. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.

j. The Contractor shall be responsible for correcting all associated ground loop problems.

k. Run wiring in panel enclosures in covered wire track.

3.1.7 Accessibility

Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, and like equipment in locations freely accessible through access doors.

3.1.8 Digital Controllers

a. Install as stand-alone control devices (see definitions).

b. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment.

3.1.9 Hand-Off-Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.10 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

3.1.10.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor 5 feet above the finished floor.

3.1.10.2 Duct Temperature Sensors

a. Probe Type: Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. Seal the duct insulation penetration vapor tight.

b. Averaging Type (and coil freeze protection thermostats): Weave the capillary tube sensing element in a serpentine fashion perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports. Prevent contact between the capillary and the duct or air handler internals. Provide a duct

access door at the sensor location. The access door shall be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 x 18 inches. For sensors inside air handlers, the sensors shall be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.10.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor.

3.1.10.4 Outside Air Temperature Sensors

Provide outside air temperature sensors in weatherproof enclosures on the north side of the building, away from exhaust hoods and other areas that may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.11 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous and accumulated energy usage.

3.1.12 Damper Actuators

Where possible, mount actuators outside the air stream in accessible areas.

3.1.13 Thermometers and Gages

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.14 Pressure Sensors

Locate pressure sensors as indicated.

3.1.15 Pneumatic Tubing

Run tubing concealed in finished areas, run tubing exposed in unfinished areas like mechanical rooms. For tubing enclosed in concrete, provide rigid metal conduit. Run tubing parallel and perpendicular to building walls. Use 5 foot maximum spacing between tubing supports. With the compressor turned off, test each tubing system pneumatically at 1.5 times the working pressure and prove it air tight, locating and correcting leaks as applicable. Caulking joints is not permitted. Do not run tubing and electrical power conductors in the same conduit.

3.1.16 Component Identification Labeling

Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions.

For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation.

3.1.17 Network and Telephone Communication Lines

When telephone lines or network connections by the Government are required, provide the Contracting Officer at least 60 days advance notice of need.

3.2 TEST AND BALANCE SUPPORT

The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel specified under Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. This support shall include:
a. On-site operation and manipulation of control systems during the testing and balancing.

b. Control setpoint adjustments for balancing all relevant mechanical systems, including VAV boxes.

c. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.3 CONTROLS SYSTEM OPERATORS MANUALS

Provide two electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.

Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Government, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

a. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.

b. A copy of the project's mechanical design drawings, including any official modifications and revisions.

c. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."

d. A copy of the project's approved Performance Verification Testing Plan and Report.

e. A copy of the project's approved final TAB Report.

f. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.

g. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.

h. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.

i. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.

j. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.

k. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Government for a minimum of two years from project acceptance, will be furnished by experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.

l. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Government for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

3.4 PERFORMANCE VERIFICATION TESTING (PVT)

3.4.1 General

The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and witnessed and approved by the Government. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the Pre-PVT Checklist is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, the Contracting Officer's representative.

3.4.2 Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed testing for Government approval. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be a clear list of test items arranged in a logical sequence. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested. The plan shall clearly describe how each item is tested, indicate where assisting personnel are required (like the mechanical contractor), and include what procedures are used to simulate conditions. Include a separate column for each checked item and extra space for comments. Where sequences of operations are checked, insert each corresponding routine from the project’s sequence of operation. For each test area, include signature and date lines for the Contractor's PVT administrator, the Contractor's QA representative, the Contracting Officer's representative, to acknowledge successful completion.

3.4.3 PVT Sample Size

Test all central plant equipment and primary air handling unit controllers unless otherwise directed. Twenty percent sample testing is allowed for identical controllers typical of terminal control like VAV boxes and fan

coil units. The Government may require testing of like controllers beyond a statistical sample if sample controllers require retesting or do not have consistent results. The Government may witness all testing, or random samples of PVT items. When only random samples are witnessed, the Government may choose which ones.

3.4.4 Pre-Performance Verification Testing Checklist

Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.

a. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).

b. Verify HVAC motors operate below full-load amperage ratings.

c. Verify all required control system components, wiring, and accessories are installed.

d. Verify the installed control system architecture matches approved drawings.

e. Verify all control circuits operate at the proper voltage and are free from grounds or faults.

f. Verify all required surge protection is installed.

g. Verify the A/C Power Table specified in "CONTROLS SYSTEM OPERATORS MANUALS" is accurate.

h. Verify all DDC network communications function properly, including uploading and downloading programming changes.

i. Using the BACnet protocol analyzer (if provided or required in this specification), verify communications are error free.

j. Verify each digital controller’s programming is backed up.

k. Verify all wiring, components, and panels are properly labeled.

l. Verify all required points are programmed into devices.

m. Verify all TAB work affecting controls is complete.

n. Verify all valve and actuator zero and span adjustments are set properly.

o. Verify all sensor readings are accurate and calibrated.

p. Verify each control valve and actuator goes to normal position upon loss of power.

q. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.

r. Verify each controller works properly in stand-alone mode.

s. Verify all safety controls and devices function properly, including freeze protection and interfaces with building fire alarm systems.

t. Verify all electrical interlocks work properly.

u. Verify all workstations, notebooks and maintenance personnel interface tools are delivered, all system and database software is installed, and graphic pages are created for each workstation and notebook.

v. Verify the as-built (shop) control drawings are completed.

3.4.5 Conducting Performance Verification Testing

a. Conduct Government-witnessed PVT after approval of the PVT Plan and the completed Pre-PVT Checklist. Notify the Contracting Officer of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems. Using the project's as-built control system (shop) drawings, the project's mechanical design drawings, the approved Pre-PVT Checklist, and the approved PVT Plan, conduct the PVT.

b. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later. Document each deficiency and corrective action taken.

c. If re-testing is required, follow the procedures for the initial PVT. The Government may require re-testing of any control system components affected by the original failed test.

3.4.6 Controller Capability and Labeling

Test the following for each controller:

a. Memory: Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.

b. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.

c. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network.

d. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.

e. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.

3.4.7 Workstation and Software Operation

For every user workstation or notebook provided:

a. Show points lists agree with naming conventions.

b. Show that graphics are complete.

c. Show the UPS operates as specified.

3.4.8 BACnet Communications and Interoperability Areas

Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

a. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.

b. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.

c. Setpoint and Parameter Modifications:

Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

d. Peer-to-Peer Data Exchange:

Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.

e. Alarm and Event Management:

Show that alarms/events are installed and prioritized according to the BAS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved (TO-OFF NORMAL, TO-NORMAL, etc.).

f. Schedule Lists:

Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.

g. Schedule Display and Modification:
Show the ability to display any schedule with start and stop times for the calendar year. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.

h. Archival Storage of Data:

Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is accomplished with BACnet Trend Log objects.

i. Modification of Trend Log Object Parameters:

Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.

j. Device and Network Management: Show the following capabilities -

(1) Display of Device Status Information

(2) Display of BACnet Object Information

(3) Silencing Devices that are Transmitting Erroneous Data

(4) Time Synchronization

(5) Remote Device Reinitialization

(6) Backup and Restore Device Programming and Master Database(s)

(7) Configuration Management of Half-Routers, Routers and BBMDs

3.4.9 Execution of Sequence of Operation

Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the internetwork.

3.4.10 Control Loop Stability and Accuracy

For all control loops tested, give the Government trend graphs of the control variable over time, demonstrating that the control loop responds to a 20% sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20% set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

3.4.11 Performance Verification Testing Report

Upon successful completion of the PVT, submit a PVT Report to the Government and prior to the Government taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated PVT Plan used during the PVT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the installation and testing of the control system is complete and meets all of the contract's requirements.

3.5 TRAINING REQUIREMENTS

Provide a qualified instructor (or instructors) with two years minimum field experience with the installation and programming of similar BACnet DDC systems. Orient training to the specific systems installed. Coordinate training times with the Contracting Officer and BAS Owner after receiving approval of the training course documentation. Training shall take place at the job site and/or a nearby Government-furnished location. A training day shall occur during normal working hours, last no longer than 8 hours and include a one-hour break for lunch and two additional 15-minute breaks. The project's approved Controls System Operators Manual shall be used as the training text. The Contractor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of training.

3.5.1 Training Documentation

Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopses of each lesson, and the instructor's background and qualifications. The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

3.5.2 Phase I Training - Fundamentals

The Phase I training session shall last one day and be conducted in a classroom environment with complete audio-visual aids provided by the contractor. Provide each trainee a printed 8.5 x 11 inch hard-copy of all visual aids used. Upon completion of the Phase I Training, each trainee should fully understand the project's DDC system fundamentals. The training session shall include the following:

a. BACnet fundamentals (objects, services, addressing) and how/where they are used on this project

b. This project's list of control system components

c. This project's list of points and objects

d. This project's device and network communication architecture

e. This project's sequences of control, and:

f. Alarm capabilities

g. Trending capabilities

h. Troubleshooting communication errors

i. Troubleshooting hardware errors

3.5.3 Phase II Training - Operation

Provide Phase II Training shortly after completing Phase I Training. The Phase II training session shall last one day and **be conducted with the subcontractor owned Laptop Host Workstation connected** to the DDC system in the field, and at other site locations as necessary. Upon completion of the Phase II Training, each trainee should fully understand the project's DDC system operation. The training session shall include the following:

a. A walk-through tour of the mechanical system and the installed DDC components (controllers, valves, dampers, surge protection, switches, thermostats, sensors, etc.)

b. A discussion of the components and functions at each DDC panel

c. Logging-in and navigating at each operator interface type

d. Using each operator interface to find, read, and write to specific controllers and objects

e. Modifying and downloading control program changes

f. Modifying setpoints

g. Creating, editing, and viewing trends

h. Creating, editing, and viewing alarms

i. Creating, editing, and viewing operating schedules and schedule objects

j. Backing-up and restoring programming and data bases

k. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics

l. Creating new graphics and adding new dynamic data displays and links

m. Alarm and Event management

n. Adding and removing network devices

The End

SECTION 23 11 25

FACILITY GAS PIPING
11/08

PART 1 GENERAL
1.1 SUMMARY

This specification section applies to incidental underground piping under building, above ground steel piping and corrugated stainless steel tubing CSST) both outside 5 feet beyond exterior walls and within buildings in compliance with NFPA 54/AGA Z223.1NFPA 58, "Fuel Gas Piping".

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service
AGA Z223.1	(2012) National Fuel Gas Code

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.1	(2010; Addenda A 2011; Addenda B 2012) Household Cooking Gas Appliances
ANSI Z21.15/CSA 9.1	(2009; Addenda A 2012, Addenda B 2013; R 2014) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves
ANSI Z21.18/CSA 6.3	(2007; Addenda A 2010; Addenda B 2012; R 2013) Gas Appliance Pressure Regulators
ANSI Z21.24/CSA 6.10	(2006; R 2011) Connectors for Gas Appliances
ANSI Z21.41/CSA 6.9	(2014) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.69/CSA 6.16	(2009; Addenda A 2012; R 2014) Connectors for Movable Gas Appliances
ANSI Z21.78/CSA 6.20	(2010; R 2015) Standard Specification for Combination Gas Controls for Gas Appliances
ANSI Z21.80/CSA 6.22	(2011; Addenda A 2012) Line Pressure Regulators

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1110	(2013) Pressure Testing of Steel Pipelines for the Transportation

	of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids or Carbon Dioxide
API RP 2003	(2008; 7th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Std 598	(2009) Valve Inspecting and Testing
API Std 607	(2010) Testing of Valves: Fire Test for Soft-Seated Quarter-Turn Valves

ASME INTERNATIONAL (ASME)

ASME A13.1	(2015) Scheme for the Identification of Piping Systems
ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.33	(2012) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, Sizes NPS 1/2 - NPS 2
ASME B16.39	(2014) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B31.9	(2014) Building Services Piping
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2016) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2016) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

CSA GROUP (CSA)

ANSI LC 1/CSA 6.26	(2016) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2013) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-83	(2014) Class 3000 Steel Pipe Unions Socket Welding and Threaded

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2015) National Fuel Gas Code
NFPA 58	(2014; TIA 13-1; TIA 13-2; Errata 13-1; TIA 13-3; Errata 14-2) Liquefied Petroleum Gas Code
NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.3 SYSTEM DESCRIPTION

The gas piping system includes natural gas piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein. Provide cathodically protected insulating joints connecting aboveground piping from the meter to the building, conforming to API RP 2003, installed where indicated.

1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markers; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shut down or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different).

1.3.2 Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer.

1.3.3 Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.4.1 Shop Drawings

Gas Piping System; G

1.4.2 Product Data

Pipe and Fittings; G
Gas Equipment Connectors; G
Gas Piping System; G
Pipe Coating Materials; G
Pressure Regulators; G
Risers; G
Transition Fittings; G
Valves; G
Warning and Identification Tape; G

1.4.3 Test Reports

Testing; G
Pressure Tests; G
Test with Gas; G

1.4.4 Certificates

Welders Procedures and Qualifications; G

1.4.5 Manufacturer's Instructions

Pipe Coating Materials; G

1.4.6 Operation and Maintenance Data

Gas Facility System and Equipment Operation; G

1.5 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

1.5.1 Welding Qualifications

a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Contracting Officer at least 24 hours in advance of tests, and perform at the work site if practicable.

b. Submit a certified copy of welders procedures and qualifications metal and PE in conformance with ASME B31.9 for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the Contracting Officer.

1.5.2 Shop Drawings

Submit drawings for complete Gas Piping System, within 30 days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54NFPA 58 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

2.2.1 Steel Pipe, Joints, and Fittings

a. Pipe: Black carbon steel in accordance with ASTM A53/A53M, Schedule 40, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: MSS SP-83(ASME B16.39), black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1, with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

2.2.2 Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL FLAMMABLE & COMBUSTIBLE.

2.2.3 Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

2.2.4 Flange Gaskets

Provide gaskets of non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

2.2.5 Pipe Threads

Provide pipe threads conforming to ASME B1.20.2M(ASME B1.20.1).

2.2.6 Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.7 Gas Transition Fittings
2.2.8 Insulating Pipe Joints

2.2.8.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.8.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.8.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

2.2.9 Flexible Connectors

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16.

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide lockable shutoff or service isolation valves as indicated in the drawings conforming to the following:

2.3.1 Valves 2 Inches and Smaller

Provide valves 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used.

2.4 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58.

2.5 REGULATORS AND SHUTOFF VALVES

Provide regulators conforming to ANSI Z21.18/CSA 6.3 for appliances ANSI Z21.78/CSA 6.20 for combination gas controls for gas appliances, and ANSI Z21.80/CSA 6.22 for line pressure regulators. Provide shutoff valves conforming to ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves.

2.6 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; ASTM A193/A193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194/A194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts shall conform with ASME B18.2.1 and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs shall extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts shall have American

Standard regular square or heavy hexagon heads; nuts shall be American Standard heavy semi finished hexagonal.

2.7 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.8 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 3/4 inch od, provide brass identification tags 1 1/2 inches in diameter with legends in depressed black-filled characters.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

3.2 GAS PIPING SYSTEM

Provide a gas piping system as indicated.

3.2.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

3.2.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.3 PROTECTIVE COVERING

3.3.1 Underground Metallic Pipe

Protect buried metallic piping and tubing from corrosion by either: (1) applying protective coatings, (2) encasement in a water tight plastic conduit; or (3) encasement in a protective system designed and listed by the manufacturer for this application. When dissimilar metals are joined underground, use gastight insulating fittings.

3.3.2 Aboveground Metallic Piping Systems
3.3.2.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed . Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances

by power wire brushing or commercial sand blasted conforming to SSPC SP 6/NACE No.3 and prime with ferrous metal primer. Finish primed surfaces with two coats of exterior oil paint.

3.4 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54 NFPA 58 AGA XR0603, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

3.4.1 Metallic Piping Installation

Bury underground piping a minimum of 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.

3.4.2 Connections Between Metallic and Plastic Piping

Connections between metallic and plastic piping are only allowed outside, underground, and with approved transition fittings.

3.4.3 Concealed Piping in Buildings

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

3.4.3.1 Piping in Partitions

Locate concealed piping and tubing in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels. Provide protection of concealed pipe and tubing in accordance with ANSI LC 1/CSA 6.26.

3.4.4 Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

3.4.5 Final Gas Connections

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.5 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.5.1 Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.5.2 Welded Metallic Joints

Conform beveling, alignment, heat treatment, and inspection of welds to NFPA 54. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

3.6 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall and cut flush with each surface. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas . Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPINGG.

3.7 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.09 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in utility or equipment rooms.

3.10 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54NFPA 58.

3.11 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.12 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54NFPA 58. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-

69. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.13 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building which is electrically continuous and bonded to a grounding electrode as required by NFPA 70.

3.14 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled. Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally.

3.15 PRESSURE REGULATOR

Provide plug cock or ball valve ahead of regulator. Install regulator outside of building and 18 inches aboveground on riser. Install gas meter in conjunction with pressure regulator. On outlet side of meter, provide a union and a 3/8 inch gage tap with plug.

3.16 TESTING

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, purge the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

3.16.1 Pressure Tests

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54as specified in NFPA 58 without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

3.16.3 Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of

NFPA 54NFPA 58. If leakage is recorded, shut off the gas supply, repair the leak, and repeat the tests until all leaks have been stopped.

3.16.4 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. LPG piping tested using fuel gas with appliances connected does not require purging. Conform testing procedures to API RP 1110. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54NFPA 58 are followed.

3.16.5 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.17 PIPE COLOR CODE MARKING

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS, conforming to ASME A13.1.

-- End of Section --

SECTION 23 81 50

VARIABLE REFRIGERANT VOLUME AIR CONDITIONING SYSTEM
THREE PIPE HEAT RECOVERY (OUTDOOR UNITS)

Part 1 – GENERAL

1.01 SYSTEM DESCRIPTION

The variable capacity, heat recovery air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, REFNET™ joints and headers, a three pipe refrigeration distribution system using PID control and Daikin VRV® condenser unit. The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant. The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit capacity. All zones are each capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance. Two-pipe, heat recovery systems utilizing a lower temperature mixed liquid/gas refrigerant to perform heat recovery are not acceptable due to reduced heating capabilities.

The Daikin condensing unit shall be interconnected to indoor unit models FXFQ, FXHQ, FXMQ, FXLQ, FXNQ, FXTQ, FXDQ, FXZQ, FXAQ and FXMQ_MF and shall range in capacity from 7,500 Btu/h to 96,000 Btu/h in accordance with Daikin's engineering data book detailing each available indoor unit. The indoor units shall be connected to the condensing unit utilizing Daikin's REFNET™ specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable.

Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with one branch cool/heat selector box (BSVQ_P). Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

Branch selector boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 96 MBH (cooling) down stream of the branch selector box. The branch selector box shall consist of five electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units. The branch selector box shall control the operational mode of the subordinate indoor units. The use of five EEV's ensures continuous heating during defrost, no heating impact during changeover and reduced sound levels. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise. Use of multi-port branch selector boxes shall not be acceptable unless spare ports are provided for redundancy.

1.02 VRVIII FEATURES AND BENEFITS

A. Voltage Platform –Heat recovery condensing units shall be available with a 208-230V/3/60 power supply.
B. Advanced Zoning – A single system shall provide for up to 58 zones.

C. Autocharging – Each system shall have a refrigerant auto-charging function.
D. Defrost Heating – Each system shall maintain continuous heating during defrost operation. Reverse cycle (cooling mode) defrost operation shall not be permitted due to the potential reduction in space temperature.
E. Oil Return Heating – Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
F. Low Ambient Cooling – Each system shall be capable of low ambient cooling operation to -4°F DB.
G. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve for independent control.
H. VFD Inverter Control – Each condensing unit shall use a high efficiency, variable speed "inverter" compressor coupled with inverter fan motors for superior part load performance.
   Compressor capacity shall be modulated automatically to maintain constant suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads.
   Indoor units shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.
I. Flexible Design –
   1. Systems shall be capable of up to 540ft (640ft equivalent) of linear piping between the condensing unit and furthest located indoor unit.
   2. Systems shall be capable of up to 3,280ft total "one-way" piping in the piping network.
   3. Systems shall have a vertical (height) separation of up to 295ft between the condensing unit and the indoor units.
   4. Systems shall be capable of up to 295ft from the first REFNET™ / branch point.
   5. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit capacity.
   6. Systems shall be capable of 49ft between indoor units.
   7. Condensing units shall be supported with a fan motor ESP up to 0.32". WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.
J. Simple Wiring – Systems shall use 16/18 AWG, 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.
K. Energy Efficiency – System shall have equivalent or better performance than high efficiency air cooled or water cooled chiller systems.
L. Outside Air – Systems shall provide outside air capability.
M. Space Saving – Each system shall have a condensing unit module footprint as small as 3' 5/8" x 2' 6-1/8" (7.66sq ft).
N. Advanced Diagnostics – Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.
O. Each condensing unit shall incorporate contacts for electrical demand shedding.
P. Advanced Controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.
   Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
Q. Low Sound Levels – Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).

1.03 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
B. All wiring shall be in accordance with the National Electric Code (NEC).
C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
D. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2002 and installed to resist the wind pressures on the equipment and the supports.
E. The condensing unit will be factory charged with R-410A.

1.04 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.05 WARRANTY

A. LIMITED WARRANTY

Daikin AC (Americas), Inc. ("Daikin AC") warrants to the customer who is the original owner and user of the Daikin AC products specified above ("Customer") that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material or workmanship. This warranty applies to parts only and is limited in duration to one (1) year from the earlier to occur of (a) the date of original installation, whether or not actual use begins on that date, or (b) eighteen (18) months from the date of shipment by Daikin AC. Customer must present proof of the original date of receipt and of installation of the Product in order to establish the effective date of this warranty. Otherwise the effective date will be deemed to be the date of manufacture plus sixty (60) days. Repaired or replacement parts are warranted for the balance of the warranty period applicable to the original part following the date on which the repaired or replacement part is provided to the Customer.

B. EXTENDED WARRANTY

For its compressors only, Daikin AC provides the above warranty (which is applicable to parts only) for a six (6) year period. This extended warranty for compressors is limited in duration to six (6) years from the earlier to occur of (a) the date of original installation, whether or not actual use begins on that date, or (b) eighteen (18) months from the date of shipment by Daikin AC, and applies to the compressor and compressor parts only. The effective date of this extended warranty shall be established as above.

C. INSTALLATION REQUIREMENTS

(1) The installing contractor shall have a minimum of three (3) years experience in the installation and operation of VRV air conditioning systems and shall have successfully installed a minimum of two VRV systems with a minimum of ten (10) indoor units.

(2) The Daikin system must be installed by a Daikin factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project may contact Direct Expansion Solutions (469-263-1000) to arrange training prior to bid day.

1.06 PERFORMANCE

A. The VRVIII REYQ system shall perform as scheduled and specified herein.

Performance Conditions
Cooling: indoor temp. of 80°F DB, 67°F WB and outdoor temp. of 95°F DB.
Heating: indoor temp. of 70°F DB and outdoor temp. of 47°F DB, 43°F WB.
Equivalent piping length: 25ft

B. OPERATING RANGE

The operating range in cooling will be (-4°F) 23°F DB ~ 122°F DB.

Each system as standard shall be capable of on site reprogramming to allow low ambient cooling operation to -4°F DB.

The operating range in heating will be 0°F DB – 77°F DB / -4°F WB – 60°F WB. Simultaneous cooling/heating operating range will be (-4°F) 23°F WB ~ 60°F WB.

Cooling mode indoor room temperature range will be 57°F-77°F WB.
Heating mode indoor room temperature range will be 59°F-80°F DB.

C. REFRIGERANT PIPING

The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps.
REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

D. DESIGN BASIS

The HVAC equipment basis of design is Daikin AC. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

1.07 HVAC EQUIPMENT ALTERNATE

A. The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation. The drawing format shall be .dxf or equivalent, on 30"x42" sheets. The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings. The alternate equipment supplier shall prepare the following drawings:

XXX HVAC Floor Plan
XXX HVAC Refrigerant Piping Plan
XXX HVAC Refrigerant Piping/Controls Details
XXX HVAC Details
XXX HVAC Schedules

The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.

Provide (2) drawing package sets plotted on 20 lb. vellum. Provide (1) drawing package in electronic format (.dxf files) on CD.

The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

B. The alternate equipment supplier shall submit as part of the equipment data package condensing unit data sheets. Data sheets to include the following:

Capacities at project design conditions: Cooling
Cooling (Btu/h)

Cooling Input Power – ducted (kW)
Cooling Input Power – ductless (kW)
Cooling Input Power – mixed (kW)

Full Load EER – ducted
Full Load EER – ductless
Full Load EER - mixed

Capacities at project design conditions: Heating
Heating (Btu/h)

Heating Input Power – ducted (kW)
Heating Input Power – ductless (kW)
Heating Input Power – mixed (kW)

Full Load COP@47F – ducted
Full Load COP@47F – ductless
Full Load COP@47F – mixed

The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.

Operating Temperature Range:
Cooling
Heating

Power Supply:
Maximum Circuit Amps (MCA)
Maximum Overcurrent Protection Amps (MOP)
Maximum Starting Current (MSC)
Condenser Fan Motor

Refrigerant:
Refrigerant Type/Charge
Control

Unit Data:
Max. Number of Indoor Units
Sound Pressure Level at 3ft. (dBA)
Weight (lbs)
Dimensions

C. The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.

Room Temperature (Cooling): _____
Room Temperature (Heating): _____
Ambient Temperature (Summer): _____
Ambient Temperature (Winter): _____
Defrost De-rate Factor: _____
Refrigerant Piping Loss: _____

D. The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:

Capacities at project design conditions:
Cooling (Btu/h)
Cooling Input Power (kW)
Full Load EER
Heating (Btu/h)
Heating Input Power (kW)
Full Load COP@47F
Air Flow (CFM)

External Static Pressure (ESP)
Electrical Data (MCA, MOP, MSC, RLA)
Weight (lbs)
Dimensions

1.08 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 00700 GENERAL:

1.08.1 Shop Drawings

Drawings

Drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements, as specified.

1.08.2 Product Data

Refrigeration System

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be adequate to demonstrate compliance with contract requirements as specified within the paragraphs:

a. Variable Refrigerant Volume Outdoor Unit (VRVO) with heat recovery

b. VRVO Components

c. Accessories

Spare Parts

Spare parts data for each different item of equipment specified.

Posted Instructions

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

Verification of Dimensions

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

Manufacturer's Multi-Year Compressor Warranty

Manufacturer's multi-year warranty for compressor(s) in air-cooled VRVO units as specified.

System Performance Tests

A schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

1.08.3 Test Reports
System Performance Tests

Three copies of the report shall be provided in bound 8 ½ x 11 inch booklets.

Part 2 -PRODUCTS

2.01 CONDENSING UNIT

A. General: The condensing unit is designed specifically for use with VRVIII series components.

1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
   High/low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.
2. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
3. The connection ratio of indoor units to condensing unit shall be permitted up to 200%.
4. Each condensing system shall be able to support the connection of up to 58 indoor units dependant on the model of the condensing unit.
5. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time.
6. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
7. The unit shall incorporate an auto-charging feature.

8. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
9. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
10. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
11. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
12. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
13. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode. Reverse cycle (cooling mode) defrost during heating operation shall not be permitted due to the potential reduction in space temperature.

B. Unit Cabinet:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 6,700 CFM to 20,650 CFM dependent on model specified.
4. Nominal sound pressure levels shall not exceed 64 dB(A).
5. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
6. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
7. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

D. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:

1. The Daikin inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G2-type” with a maximum speed of 7,980 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 4% to 100%.
5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. Units sized 6-12 tons shall contain a minimum of 2 compressors. 14 ton units shall contain a minimum of 3 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

F. Electrical:

1. The power supply to the condensing unit shall be 208-230 volts, 3 phase, 60 hertz +/- 10%.
2. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

2.02 BSVQ BRANCH SELECTOR BOX FOR VRVIII HEAT RECOVERY SYSTEM

A. General: The BSVQ36PVJU, BSVQ60PVJU and BSVQ96PVJU branch selector boxes are designed specifically for use with VRVIII series heat recovery system components.

1. These selector boxes shall be factory assembled, wired, and piped.
2. These BSVQ_P branch controllers must be run tested at the factory.
3. These selector boxes must be mounted indoors.
4. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

B. Unit Cabinet:

1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house 5 electronic expansion valves for refrigerant control.
3. The cabinet shall contain a subcooling heat exchanger.
4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

C. Dimensions:

1. Each BSVQ_P unit shall be no larger than 8-3/16” x 15-5/16” x 12-7/8”.

D. Refrigerant Valves:

1. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
2. The refrigerant connections must be of the braze type.
3. Each circuit shall have at least one (36,000 Btu/h indoor unit or smaller for the BSVQ36PVJU, 60,000 Btu/h indoor unit or smaller for the BSVQ60PVJU and 96,000 Btu/h indoor unit or smaller for the BSVQ96PVJU) branch selector box. Use of multi-port branch selector boxes shall not be acceptable unless spare ports are provided for redundancy.
4. Multiple indoor units may be connected to a branch selector box with the use of a REFNET™ joint provided they are within the capacity range of the branch selector.

E. Condensate Removal:

1. The unit shall not require provisions for condensate removal.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
3. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.
4. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.03 VRV OUTDOOR UNITS

* Refer to Section 23 82 20.

Part 3 -EXECUTION

3.01 INSTALLATION REQUIREMENTS

The system must be installed by a Daikin factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project may contact Direct Expansion Solutions (469-263-1000) to arrange training prior to bid day.

-- End of Section --

SECTION 23 82 02.00 10

UNITARY HEATING AND COOLING EQUIPMENT
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 490 I-P	(2011) Performance Rating of Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers
AHRI 540	(2004) Performance Rating Of Positive Displacement Refrigerant Compressors and Compressor Units
AHRI 700	(2015; Addendum 1 2015) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 340/360	(2007; Addendum 1 2010; Addendum 2 2011) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2013; Addenda A 2014; ERTA 1 2014; Addenda A-T AND SUPP 2015; ERTA 2 2015; INT 1 2015; ERTA 3 2015; ERTA 4 2016) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2012; Errata 1 2013; INT 1 2014; ADD A, B, AND D SUPP 2015; INT 3 2015; Errata 2 2015; ADD C 2015; ADD E, F 2016) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 64	(2011) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1071	(2012) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2015b) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2011) Enclosures
NEMA MG 1	(2014) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2015) Heating and Cooling Equipment
UL 207	(2009; Reprint Jun 2014) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 900	(2015) Standard for Air Filter Units

1.2 SYSTEM DESCRIPTION

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 746 W (1 horsepower) and above with open, drip proof, totally enclosed, or explosion proof fan cooled enclosures, shall be the premium efficiency type in accordance with NEMA MG 1. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.3.1 Shop Drawings

Drawings

1.3.2 Product Data

Materials and Equipment
Spare Parts
Posted Instructions
Verification of Dimensions
Coil Corrosion Protection
System Performance Tests

1.3.3 Test Reports

Refrigerant Tests, Charging, and Start-Up; G
System Performance Tests; G

1.3.4 Certificates

Materials and Equipment
Service Organization

1.3.5 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.4 QUALITY ASSURANCE

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Submit drawings provided in adequate detail to demonstrate compliance with contract requirements. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide Materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. Submit manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements.

a. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

b. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. Where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted.

d. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above shall be included. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self-certify that his application data complies with project performance requirements in accordance with the specified test standards.

e. Products shall be supported by a service organization. Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract. System components shall be environmentally suitable for the indicated locations.

2.1.2 Nameplates

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.1.3 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

2.2 UNITARY EQUIPMENT, SPLIT SYSTEM

Unit shall be an air-cooled, split system which employs a remote condensing unit, a separate indoor unit, and interconnecting refrigerant piping. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ANSI/AHRI 340/360. Unit shall be provided with necessary fans, air filters, internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph REMOTE CONDENSER OR CONDENSING UNIT. Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Condenser or outdoor fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have totally enclosed enclosures.

2.2.1 Air-to-Refrigerant Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.3 REMOTE CONDENSING UNIT

Each remote condenser coil shall be fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 120 degrees F at 95 degrees F ambient. Unit shall be provided with low ambient condenser controls to ensure proper operation in an ambient temperature of 40 degrees F. Fan and cabinet construction shall be provided as specified in paragraph "Unitary Equipment Components". Fan and condenser motors shall have totally enclosed enclosures.

2.3.1 Air-Cooled Condenser

Unit shall be rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

2.3.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between condensing unit and evaporator units shall be provided.

2.3.1.2 Condensing Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.3.1.3 Unit Controls

The control system shall be complete with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include control transformer, fan motor starters, solid-state speed control, time delay start-up, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.3.2 Evaporative Condenser

Each unit shall be the counter-flow blow-through design, with single-side air entry. The unit shall have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section, the cabinet, etc. shall be not lighter than 16-gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 2.5 ounces/square foot of surface. Cut edges shall be given a protective coating of zinc-rich compound. After assembly, the manufacturer's standard zinc chromatized aluminum or epoxy paint finish shall be applied to the exterior of the unit. Unit shall be rated in accordance with AHRI 490 I-P and tested in accordance with the requirements of ASHRAE 64.

2.3.2.1 Pan Section

The pan shall be watertight and be provided with drain, overflow, and make-up water connections. Standard pan accessories shall include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.3.2.2 Fan Section

Fan shall be the centrifugal type in accordance with paragraph "Fans". Fan and fan motor shall not be located in the discharge airstream of the unit. Motors shall have totally enclosed enclosure and be suitable for the indicated service. The condensing unit design shall prevent water from entering into the fan section.

2.3.2.3 Condensing Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter without fins. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged.

2.3.2.4 Unit Controls

The evaporative condenser unit shall be provided with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers shall modulate to reduce the airflow through the evaporative condenser. Controls shall include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycling of a fan motor on and off shall be in accordance with the manufacturer.

2.3.3 Compressor

Unit shall be rated in accordance with AHRI 540. Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Units 120,000 Btuh and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, and high and low pressure safety cutoffs and protection against short cycling.

2.4 EQUIPMENT EFFICIENCY

Unit shall have an efficiency as indicated.

2.5 UNITARY EQUIPMENT COMPONENTS

2.5.1 Refrigerant and Oil

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. Refrigerants shall meet the requirements of AHRI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.5.2 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a totally enclosed enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. V-belt driven fans shall be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and adjustable pitch sheaves.

2.5.3 Primary/Supplemental Heating

2.5.3.1 Electric Heating Coil

Coil shall be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil shall be unit-mounted. Coil shall be of the nickel chromium resistor type. Coil shall be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized.

Coil casing and support brackets shall be of galvanized steel or aluminum. Coil shall be mounted to eliminate noise from expansion and contraction and be completely accessible for service.

2.5.4 Air Filters

Air filters shall be listed in accordance with requirements of UL 900.

2.5.4.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth sectional type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.2. Initial resistance at 500 feet/minute will not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.5.5 Coil Frost Protection

Each circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

2.5.6 Pressure Vessels

Pressure vessels shall conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, pressure components shall be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces shall be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.5.6.1 Hot Gas Muffler

Unit shall be selected by the manufacturer for maximum noise attenuation. Units rated for 30 tons capacity and under may be field tunable type.

2.5.6.2 Liquid Receiver

A liquid receiver shall be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver shall be designed, filled, and rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver shall be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves; thermal well for thermostat; float switch column; external float switches; and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver shall be provided with a relief valve of capacity and setting in accordance with ANSI/ASHRAE 15 & 34.

2.5.6.3 Oil Separator

Separator shall be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator shall not exceed 10 psi during the removal of hot gas entrained oil. Connections to compressor shall be as recommended by the compressor manufacturer. Separator shall be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, filter for removal of all

particulate sized 10 microns and larger, thermometer and low temperature thermostat fitted to thermal well, immersion heater, external float valve fitted with three-valve bypass, and strainer.

2.5.6.4 Oil Reservoir

Reservoir capacity shall equal one charge of all connected compressors. Reservoir shall be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header shall be provided with a 5 psi pressure differential relief valve. Reservoir shall be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.5.7 Internal Dampers

Dampers shall be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions shall be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers shall have minimum position stops, have automatic modulation and operate as specified.

2.5.8 Cabinet Construction

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness shall be 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C1071. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.5.8.1 Indoor Cabinet

Indoor cabinets shall be suitable for the specified indoor service and enclose all unit components.

2.5.8.2 Outdoor Cabinet

Outdoor cabinets shall be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.6 ACCESSORIES

2.6.1.1 Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.6.1.2 Fan Section

Fan shall be the centrifugal type in accordance with paragraph "Fans". Motors shall have totally enclosed enclosures and be suitable for the indicated service.

2.6.2 Refrigerant Signs

Refrigerant signs shall be a medium-weight aluminum type with a baked enamel finish. Signs shall be suitable for indoor or outdoor service. Signs shall have a white background with red letters not less than 0.5 inches in height.

2.6.2.1 Installation Identification

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

2.6.3 Gaskets

Gaskets shall conform to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.6.4 Bolts and Nuts

Bolts and nuts shall be in accordance with ASTM A307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.6.5 Bird Screen

Screen shall be 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

2.7 FINISHES

2.7.1 Factory Coating

2.7.1.2 Equipment and Components

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.7.2 Factory Applied Insulation

Refrigeration equipment shall be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice.

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Refrigerant Piping

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with the manufacturer’s recommendations and installation instructions.

2.8.2 Ductwork

Ductwork shall be provided and installed in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.8.3 Temperature Controls

Temperature controls shall be provided by the manufacturer with supplemental features as shown on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work. Submit a letter, at least 2 weeks prior to beginning construction, including the date the site was visited, confirmation of existing conditions, and any discrepancies found.

3.2 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ANSI/ASHRAE 15 & 34. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 150 mm (6 inch) concrete pad doweled in place.

3.2.2 Field Applied Insulation

Field applied insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 DEMONSTRATIONS

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. Submit a schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

b. Submit the field posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

c. The posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. Submit 6 complete copies of an operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

d. Submit 6 complete copies of maintenance manual in bound 216 by 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as specified by the system manufacturer. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to

verify proper refrigerant levels in accordance with manufacturer's recommendations. Submit 6copies of each test containing the information described below in bound 8-1/2 by 11 inch booklets. Individual reports shall be submitted for the refrigerant system tests.

a. The date the tests were performed.
b. A list of equipment used, with calibration certifications.
c. Initial test summaries.
d. Repairs/adjustments performed.
e. Final test results.

3.5.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.5.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Six copies of the report provided in bound 8-1/2 by 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

a. Submit a schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced.

c. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Field tests shall be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit 6 copies of the report provided in bound 8-1/2 by 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.
(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

-- End of Section --

SECTION 23 82 20

VARIABLE REFRIGERANT VOLUME AIR CONDITIONING
-HEAT RECOVERY/INDOOR UNITS

Part 1 – GENERAL

VARIABLE REFRIGERANT VOLUME (VRV / VRV-S) AIR CONDITIONING
SPECIFICATION – Heat Recovery/Heat Pump Indoor Units

1.01 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).

C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

D. The outdoor unit will be factory charged with R-410A.

1.02 INSTALLING CONTRACTOR'S QUALIFICATIONS

1.02.1 The installing contractor shall have a minimum of three (3) years experience in the installation and operation of VRV air conditioning systems and shall have successfully installed a minimum of two VRV systems with a minimum of ten (10) indoor units.

1.02.2 The system shall be installed by a contractor/dealer whose personnel have been factory trained by the VRV system manufacturer. Refer to Par. 3.01.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 00700 GENERAL:

1.03.1 Shop Drawings

Detail Drawings; G
Piping Diagram (refer to Par. 1.05B)

1.03.2 Product Data

Variable Refrigerant Volume Air Conditioning (Heat Recovery) Indoor Units; G

1.03.3 Test Reports

Performance Tests; G

1.03.4 Manufacturer's Instructions

Manufacturer's Installation Instructions
Operation and Maintenance Training

1.03.5 Operation and Maintenance Data

Operation and Maintenance Manuals
Variable Refrigerant Volume Air Conditioning (Heat Recovery) Indoor Units; G

1.04 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.05 WARRANTY

The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The units shall have a limited labor warranty for a period of one (1) year from date of installation. The compressors shall have a warranty of six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Daikin AC (Americas), Inc. according to Daikin's terms and conditions. All warranty service work shall be performed by a Daikin factory trained service professional.

1.06 PERFORMANCE

A. DESIGN BASIS

The HVAC equipment basis of design is Daikin AC. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

B. PIPING DIAGRAM

Prior to ordering the refrigeration piping for the project, the contractor shall verify and submit to the system manufacturer the lengths of all sections of refrigeration piping between items of equipment (or joints) required for the project. The manufacturer shall provide to the contractor a Piping Diagram that shows the piping sizes and lengths of all sections of refrigeration piping to be provided. This diagram shall be submitted to the Contracting Officer per Par. 1.02.1.

1.07 HVAC EQUIPMENT ALTERNATE

A. The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation. The drawing format shall be .dxf or equivalent, on 30"x42" sheets. The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings. The alternate equipment supplier shall prepare the following drawings:

XXX HVAC Floor Plan
XXX HVAC Refrigerant Piping Plan
XXX HVAC Refrigerant Piping/Controls Details
XXX HVAC Details
XXX HVAC Schedules

The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.

Provide (2) drawing package sets plotted on 20 lb. vellum. Provide (1) drawing package in electronic format (.dxf files) on CD.

The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

B. The alternate equipment supplier shall submit as part of the equipment data package outdoor unit data sheets. Data sheets to include the following:

Capacities at project design conditions: Cooling
Cooling (Btu/h)

Cooling Input Power
(kW)

Capacities at project design conditions: Heating
Heating (Btu/h)

Heating Input Power
(kW)

The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed outdoor ambient, and indoor space temperature conditions including de-rate factors for defrost and refrigerant piping lengths.

Operating Temperature Range:
Cooling
Heating

Power Supply:
Maximum Circuit Amps (MCA)
Maximum Overcurrent Protection Amps (MOP)
Maximum Starting Current (MSC)
Outdoor Fan Motor

Refrigerant:
Refrigerant Type/Charge
Control

Unit Data:
Max. Number of Indoor Units
Sound Pressure Level at 3ft. (dBA)
Weight (lbs)
Dimensions

C. The alternate equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.

Room Temperature (Cooling): _____
Room Temperature (Heating): _____
Ambient Temperature (Summer): _____
Ambient Temperature (Winter):_____
Defrost De-rate Factor:_____
Refrigerant Piping Loss in cooling (correction factor): _____
Refrigerant Piping Loss in heating (correction factor): _____

D. The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:

Capacities:
Cooling (Btu/h)
Heating (Btu/h)
Air Flow (CFM)

External Static Pressure (ESP)
Electrical Data (MCA, MOP, MSC)
Weight (lbs)
Dimensions

Part 2 – PRODUCTS

2.01 FXMQ P - CONCEALED CEILING DUCTED UNIT (Med. Static)

A. General: Daikin indoor unit FXMQ_P shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in capacities from 7,500 Btu/h to 48,000 Btu/h. Model numbers are FXMQ07PVJU, FXMQ09PVJU, FXMQ12PVJU, FXMQ18PVJU, FXMQ24PVJU, FXMQ30PVJU, FXMQ36PVJU and FXMQ48PVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E71 and BRC2A71. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8” from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 40 dB(A) at low speed measured 5 feet below the ducted unit.

B. Performance: Each unit's performance is based on nominal operating conditions

Model Number	Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	Heating (Indoor 47°F DB / 43°F WB, Outdoor 70°F DB, 25 ft pipe length)
FXMQ07PVJU	7,500	8,500
FXMQ09PVJU	9,500	10.500
FXMQ12PVJU	12,000	13,500
FXMQ18PVJU	18,000	20,000
FXMQ24PVJU	24,000	27,000
FXMQ30PVJU	30,000	34,000
FXMQ36PVJU	36,000	40,000
FXMQ48PVJU	48,000	54,000

C. Indoor Unit:

1. The Daikin indoor unit FXMQ_P shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with an automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

7. Fan motor external static pressure range for nominal airflow:

Model Number	Fan ESP (in. WG)
FXMQ07PVJU	0.40 – 0.12
FXMQ09PVJU	0.40 – 0.12
FXMQ12PVJU	0.40 – 0.12
FXMQ18PVJU	0.80 – 0.20
FXMQ24PVJU	0.80 – 0.20
FXMQ30PVJU	0.80 – 0.20
FXMQ36PVJU	0.80 – 0.20
FXMQ48PVJU	0.80 – 0.20

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4” outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 18-3/8” lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.
3. The unit shall be compatible with a Daikin intelligent Touch advanced multi-zone controller or an intelligent Manager III customizable BMS. Consult with Daikin prior to applying controls.

I. Optional Accessories Available:

1. Remote “in-room” sensor kit KRCS01-4B (recommended).
   i. The Daikin wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set

temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

2.02 FXAQ – WALL MOUNTED UNIT

A. General: Daikin indoor unit FXAQ shall be a wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. This compact design with finished white casing shall be available in capacities from 7,500 Btu/h to 24,000 Btu/h. Model numbers are FXAQ07MVJU, FXAQ09MVJU, FXAQ12MVJU, FXAQ18MVJU and FXAQ24MVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E71 and BRC2A71. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 40 dB(A) at low speed measured at 3.3 feet below and from the unit.

B. Performance: Each unit's performance is based on nominal operating conditions:

Model Number	**Cooling** (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	**Heating** (Indoor 47°F DB / 43°F WB, Outdoor 70°F DB, 25 ft pipe length)
FXAQ07MVJU	7,500	8,500
FXAQ09MVJU	9,500	10,500
FXAQ12MVJU	12,000	13,500
FXAQ18MVJU	18,000	20,000
FXAQ24MVJU	24,000	27,000

C. Indoor Unit:

1. The Daikin indoor unit FXAQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through a resin net mold resistant filter.
5. The indoor units shall be equipped with a condensate pan.
6. The indoor units shall be equipped with a return air thermistor.

7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
8. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.
6. A condensate pan shall be located in the unit.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.
3. The unit shall be compatible with a Daikin intelligent Touch advanced multi-zone controller or an intelligent Manager III customizable BMS. Consult with Daikin prior to applying controls.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

The system must be installed by a Daikin factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project may contact Direct Expansion Solutions (469-263-1000) to arrange training prior to bid day.

-- End of Section --

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2013) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015) National Electrical Safety Code
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to certain sections of HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 ELECTRICAL of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.3 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be _7.2/12.5_ kV primary, three phase, four wire, 60 Hz, and _120/208___ volts secondary, three phase, four wire.

1.4 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.4.1 Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.4.2 Product Data

Submittal shall include performance and characteristic curves.

1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.5.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.8 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.9 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 1 by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.10 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements specified in the technical sections.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in the section specifying the associated electrical equipment.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --

SECTION 26 12 19.10

THREE-PHASE PAD-MOUNTED TRANSFORMERS
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2016) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D877/D877M	(2013) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D92	(2012b) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2016) Pour Point of Petroleum Products

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 386	(2006; INT 1 2011) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015; INT 12 2016) National Electrical Safety Code
IEEE C37.47	(2011) Standard for High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2015) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.34	(2009) Standard for Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution

	Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
IEEE C57.12.90	(2015) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2012) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013) Grounding and Bonding Equipment

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.3.1 Shop Drawings

Pad-mounted transformer drawings; G.

1.3.2 Product Data

Pad-mounted transformers; G.

Submittal shall include manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

1.3.3 Test Reports

Acceptance checks and tests; G.

Submittal shall include acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

1.3.4 Certificates

Transformer Efficiencies; G.

Submit certification, including supporting calculations, from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Efficiencies."

1.3.5 Manufacturer's Field Reports

Pad-mounted transformer design tests; G.

Pad-mounted transformer routine and other tests; G.

1.3.6 Operation and Maintenance Data

Transformer

1.3.7 Closeout Submittals

Transformer test schedule; G.
Submit report of test results as specified by paragraph entitled "Field Quality Control."

1.3.8 Reduced Submittal Requirements

Transformers designed and manufactured by ABB in Jefferson City, MO; by Cooper Power Systems in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel,

MS need not submit the entire submittal package requirements of this contract. Instead, the following items shall be submitted:

a. A certification, signed by the manufacturer, stating that the technical requirements of this specification shall be met.

b. An outline drawing of the transformer with devices identified (paragraph entitled "Pad-Mounted Transformer Drawings", item a).

c. ANSI nameplate data of the transformer (paragraph entitled "Pad-Mounted Transformer Drawings", item b.

d. Manufacturer's published time-current curves (properly overlaid on one full size logarithmic paper) of the transformer high side fuses (paragraph entitled "Pad-Mounted Transformer Drawings", item e) with transformer damage curve, inrush curve, and thru fault current indicated.

e. Routine and other tests (in PART 2, see paragraph entitled "Source Quality Control", subparagraph entitled "Routine and Other Tests"), shall be conducted by the manufacturer and may be witnessed by the government. Provide transformer test schedule required by submittal item "1.4.7 Closeout Submittals". Provide certified copies of the tests.

f. Provide acceptance test reports required by submittal item "1.4.3 Test Reports".

g. Provide operation and maintenance manuals required by submittal item "1.4.6 Operation and Maintenance Data".

1.4 QUALITY ASSURANCE

1.4.1 Pad-Mounted Transformer Drawings

Drawings shall indicate, but not be limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

c. Elementary diagrams and wiring diagrams.

d. Manufacturer's published time-current curves (on full size logarithmic paper) of the transformer high side fuses.

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include

applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 MAINTENANCE

1.5.1 Additions to Operation and Maintenance Data

In addition to requirements of 1.4.6, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

f. Actual nameplate diagram

g. Date of purchase

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein.

2.2.1 Compartments

The high- and low-voltage compartments shall be separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

High-voltage compartment shall contain the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, load-break switch handle(s), access to oil-immersed bayonet fuses, dead-front surge arresters, tap changer handle, connector parking stands, protective caps, and ground pad.

a. Insulated high-voltage load-break connectors: IEEE 386, rated 15 kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

b. Bushing well inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

c. Load-break switch
Radial-feed oil-immersed type rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

d. Provide bayonet type, oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified. Connect current-limiting fuses ahead of the radial-feed load-break switch.

e. Surge arresters: IEEE C62.11, rated 9 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap. Provide three arresters for radial feed circuits.

f. Parking stands: Provide a parking stand near each bushing.

g. Protective caps: IEEE 386, 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushings.

2.2.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, accessories, metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Accessories shall include drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

2.2.2 Transformer

a. Less-flammable liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer shall be rated as scheduled.

c. Transformer voltage ratings: 12,470 V Delta 480V GrdY 277.

d. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Tap changers shall clearly indicate which tap setting is in use.

e. Minimum tested percent impedance at 85 degrees C shall not be less than the following values:

2.50 for units rated 75kVA and below
2.87 for units rated 112.5kVA to 300kVA
4.03 for 500kVA rated units

f. Audible sound levels shall comply with the following:

kVA	DECIBELS (MAX
75	51
112.5	55
150	55
225	55
300	55
500	56

g. Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. Transformer shall have its kVA rating conspicuously displayed using 3 inch high yellow letters on its enclosure. The transformer shall have an insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

2.2.2.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. No-load losses (NLL) shall be referenced at 20 degrees C. Load losses (LL) shall be referenced at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. That table is based on requirements contained within 10 CFR 431, Subpart K.

kVA	EFFICIENCY (percent)
15	98.36
30	98.62
45	98.76
75	98.91
112.5	99.01
150	99.08
225	99.17
300	99.23
500	99.25

2.2.3 Insulating Liquid

a. Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

The fluid shall be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable" fluids. The fluid shall meet the following fluid properties:

1. Pour point: ASTM D97, less than -15 degree C

2. Aquatic biodegradation: EPA 712-C-98-075, 100 percent

3. Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass.

2.2.3.1 Liquid-Filled Transformer Nameplates

Distribution transformers shall be provided with nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Corrosion Protection

Bases and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within (3 inches) of concrete pad.

Paint entire transformer assembly Scotchlite Brown (FSC 10091). Paint coating system shall comply with IEEE C57.12.28 regardless of base, cabinet, and tank material.

2.3 WARNING SIGNS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

2.4 ARC FLASH WARNING LABEL

Provide warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. The label format shall be as indicated.

2.5 GROUNDING AND BONDING

UL 467 Provide grounding and bonding as indicated.

2.6 PADLOCKS

Padlocks shall be provided for pad-mounted equipment. Padlocks shall be keyed as directed by the Contracting Officer. Padlocks shall comply with Section 08 71 00 DOOR HARDWARE.

2.8 SOURCE QUALITY CONTROL

2.8.2 Design Tests

IEEE C57.12.00 states that "design tests are made only on representative apparatus to substantiate the ratings assigned to all other apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for the specified transformer. Design tests shall have been performed in accordance with IEEE C57.12.90 prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests shall include the primary windings only of that transformer.

1. IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

2. State test voltage levels.

3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.8.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests shall be performed in accordance with IEEE C57.12.90 by the manufacturer on the actual transformer prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. Phase relation

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

1. Impulse

2. Applied voltage

3. Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as indicated. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

Provide separate copper grounding conductors and connect them to the ground loop as indicated.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

ANSI C12.1.

3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.5 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side.

3.6.2 Sealing

When the installation is complete, the Contractor shall seal all entries into the equipment enclosure with an approved sealing method. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

3. Inspect anchorage, alignment, and grounding.

4. Verify the presence of PCB content labeling.

5. Verify the bushings and transformer interiors are clean.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

7. Verify correct liquid level in tanks and bushings.

8. Verify that positive pressure is maintained on gas-blanketed transformers.

9. Perform specific inspections and mechanical tests as recommended by manufacturer.

10. Verify de-energized tap changer position is left as specified.

11. Verify the presence of transformer surge arresters.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

2. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
3. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Calculate polarization index.

4. Perform turns-ratio tests at all tap positions.

5. Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer’s published data.

6. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests.

7. Measure the resistance of each high-voltage winding in each de-energized tap-changer position. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.

8. Remove and test a sample of insulating liquid for the following: Dielectric breakdown voltage, Acid neutralization number, Specific gravity, Interfacial tension, Color, Visual Condition, Water in insulating liquids (Required on 25 kV or higher voltages and on all silicone-filled units.), and Power factor or dissipation factor.

9. Perform dissolved-gas analysis (DGA) on a sample of insulating liquid.

3.7.1.4 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

1. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.7.1.5 Surge Arresters, Medium-Voltage

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, grounding, and clearances.

4. Verify the arresters are clean.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform an insulation-resistance test on each arrester, phase terminal-to-ground.

3. Test grounding connection.

3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
02/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2013) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2005) American National Standard for Electrical Metallic Tubing (EMT)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 4	(2015) Terminal Blocks
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA VE 1	(2009) Standard for Metal Cable Tray Systems
NEMA WD 1	(1999; R 2005; R 2010) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2012) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011) American National Standard for Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code
NFPA 70E	(2015; ERTA 1 2015) Standard for Electrical Safety in the Workplace

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-569	(2015d) Commercial Building Standard for Telecommunications Pathways and Spaces
TIA-607	(2011b) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	Control of Hazardous Energy (Lock Out/Tag Out)

UNDERWRITERS LABORATORIES (UL)

UL 1063	(2006; Reprint Jul 2012) Machine-Tool Wires and Cables
UL 1242	(2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2014;Reprint Mar 2015) Surge Protective Devices
UL 1660	(2014) Liquid-Tight Flexible Nonmetallic Conduit
UL 198M	(2003; Reprint Feb 2013) Standard for Mine-Duty Fuses

UL 360	(2013; Reprint Jan 2015) Liquid-Tight Flexible Steel Conduit
UL 4248-1	(2007; Reprint Oct 2013) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2007; Reprint Dec 2012) UL Standard for Safety Fuseholders - Part 12: Class R
UL 44	(2014; Reprint Feb 2015) Thermoset-Insulated Wires and Cables
UL 467	(2007) Grounding and Bonding Equipment
UL 486A-486B	(2013; Reprint Feb 2014) Wire Connectors
UL 486C	(2013; Reprint Feb 2014) Splicing Wire Connectors
UL 489	(2013; Reprint Mar 2014) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(2012; Reprint Oct 2014) Attachment Plugs and Receptacles
UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment
UL 510	(2005; Reprint Jul 2013) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013) Metallic Outlet Boxes
UL 514B	(2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Dec 2014) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 67	(2009; Reprint Apr 2015) Standard for Panelboards
UL 797	(2007; Reprint Dec 2012) Electrical Metallic Tubing -- Steel
UL 817	(2015; Reprint Jan 2016) Standard for Cord Sets and Power-Supply Cords
UL 83	(2014) Thermoplastic-Insulated Wires and Cables
UL 854	(2004; Reprint Nov 2014) Standard for Service-Entrance Cables
UL 870	(2008; Reprint Feb 2013) Standard for Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2006; Reprint Jun 2012) Ground-Fault Circuit-Interrupters

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

1.3.1 Shop Drawings

Panelboards; G

Cable trays; G

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices.

Wireways; G

1.3.2 Product Data

Receptacles; G

Circuit breakers; G

Switches; G

Transformers; G

Enclosed circuit breakers; G

Motor controllers; G

Manual motor starters; G

Metering; G

Surge protective devices; G

Include performance and characteristic curves.

1.3.3 Test Reports

600-volt wiring test; G
Grounding system test; G
Ground-fault receptacle test; G

1.3.4 Operation and Maintenance Data

Electrical Systems, Data Package 5; G

Metering, Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein.

1.4 QUALITY ASSURANCE

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40, 40 mils thick.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 Not used.

2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.4.1 Outlet Boxes for Telecommunications System

Provide the following:

a. Standard type 4 inches square by 2 1/8 inches deep.

b . Outlet boxes for wall-mounted telecommunications outlets: 4 by 2 1/8 by 2 1/8 inches deep.

c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.

2.4.2 Clock Outlet for Use in Other Than Wired Clock System

Provide the following:

a. Outlet box with plastic cover, where required, and single receptacle with clock outlet plate.

b. Receptacle: recessed sufficiently within box to allow complete insertion of standard cap, flush with plate.

c. Suitable clip or support for hanging clock: secured to top plate.

d. Material and finish of plate: as specified in paragraph DEVICE PLATES of this section.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

2.6 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

2.6.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. All conductors: copper.

2.6.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

2.6.1.3 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

2.6.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

2.6.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

2.6.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

2.6.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.6.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.6.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.6.6 Metal-Clad Cable

Type MC cable is not allowed on this project.

2.6.7 Cord Sets and Power-Supply Cords

UL 817.

2.7 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.8 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings: nylon.

d. Plates on finished walls: nylon minimum 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.

e. Screws: machine-type with countersunk heads in color to match finish of plate.

f. Sectional type device plates are not be permitted.

g. Plates installed in wet locations: gasketed and UL listed for "wet locations."

2.9 SWITCHES

2.9.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole or three-way, as indicated, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: ivory thermoplastic.

b. Wiring terminals: screw-type, side-wired.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.9.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts or 277 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.9.4 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches, as indicated, per NEMA ICS 6.

2.10 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch.

2.10.1 Fuseholders

Provide in accordance with UL 4248-1.

2.10.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-1 or RK-5 (time-delay type), as indicated. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.11 RECEPTACLES

Provide the following:

a. UL 498, hospital grade, grounding-type.

b. Ratings and configurations: as indicated.

c. Bodies: ivory as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

2.11.1 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations". Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.11.2 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.11.3 Range Receptacles

NEMA 14-30 configuration, rated 30 amperes, 125/250 volts. (Furnish one matching plug with each receptacle.)

2.12 PANELBOARDS

Provide panelboards in accordance with the following:

a. UL 67 and UL 50 having a short-circuit current rating, as indicated.

b. Panelboards: circuit breaker-equipped.

c. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

d. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.

e. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise.

f. Main breaker: "separately" mounted "above" or "below" branch breakers.

g. Where "space only" is indicated, make provisions for future installation of breakers.

h. Directories: indicate load served by each circuit in panelboard.

i. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).

j. Type directories and mount in holder behind transparent protective covering.

k. Panelboards: listed and labeled for their intended use.

l. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.12.1 Enclosure

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication.

c. Cabinets: painted in accordance with paragraph PAINTING.

d. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

e. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

f. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.

g. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

h. Each door: fitted with a combined catch and lock, except that doors over 24 inches long provided with a three-point latch having a knob with a T-handle, and a cylinder lock.

i. Keys: two provided with each lock, with all locks keyed alike.

j. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.12.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.12.3 Circuit Breakers

UL 489, thermal magnetic-type, having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.12.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.12.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A ground-fault circuit interrupter.

2.12.3.3 Circuit Breakers for HVAC Equipment

Provide circuit breakers for HVAC equipment having motors (group or individual) marked for use with HACR type and UL listed as HACR type.

2.13 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. [Provide solid neutral.]

2.14 TRANSFORMERS

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled, ventilated.

b. Provide transformers in NEMA 1 enclosure.

c. Transformer insulation system:

(1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C.

(2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C.

d. Transformer of 150 degrees C temperature rise: capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

e. Transformers: quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.15 MOTOR CONTROLLERS

Provide motor controllers in accordance with the following:

a. UL 508, NEMA ICS 1, and NEMA ICS 2.

b. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

c. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.

d. Provide protection for motors from immediate restart by a time adjustable restart relay.

e When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.

f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.

g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.

h. Control circuit connections to hand / off / automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.

i. Provide selector switch with the means for locking in any position.

j. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

l. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.

m. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

n. Minimum short circuit withstand rating of combination motor controller: 10,000 rms symmetrical amperes.

2.15.1 Control Wiring

Provide control wiring in accordance with the following:

a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards.

b. Hinge wire: Class K stranding.
c. Current transformer secondary leads: not smaller than No. 10 AWG.

d. Control wire minimum size: No. 14 AWG.

e. Power wiring for 480-volt circuits and below: the same type as control wiring with No. 12 AWG minimum size.

f. Provide wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.15.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

a. NEMA ICS 4.

b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.

c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.

d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.

e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four (4) spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.

f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.

f. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.15.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.15.3 Control Circuits

Control circuits: maximum voltage of 120 volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. Provide one fused secondary lead with the other lead grounded.

2.15.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.15.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

2.15.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.16 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single, Double or Three pole, as indicated, designed for surface mounting with overload protection.

2.17 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.18 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes and conduits with pull wires for telecommunications outlets and pathway.

2.19 Not Used.

2.20 GROUNDING AND BONDING EQUIPMENT

2.20.1 Ground Rods

UL 467. Ground rods: copper-clad steel, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional ground rods are permitted.

2.21 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.22 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.

e. Provide red laminated plastic label with white center core where indicated.

f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: 1 by 2.5 inches.

h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.23 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.24 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING .

2.25 WIREWAYS

UL 870. Material: steel epoxy painted 16 gauge for heights and depths up to 6 by 6 inches. Provide in length required for the application with screw-cover NEMA enclosure per NEMA ICS 6.

2.26 Not Used.

2.27 Not Used.

2.28 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service. Provide surge protectors in a NEMA 3R enclosure per NEMA ICS 6. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-

Phase to phase (L-L)
Each phase to neutral (L-N)

SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G).

2.29 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semi gloss finish.

f. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Light Gray.

g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.30 SOURCE QUALITY CONTROL

2.30.1 Transformer Factory Tests

Submittal: include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA “design” and “prototype” tests that were made on transformers electrically and mechanically equal to those specified.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

3.1.4 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.4.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicated number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.5 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor:

separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Shared neutral, or multi-wire branch circuits, are not permitted. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00, FIRESTOPPING.

3.1.5.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 890-N (200-pound) force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.6 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project. Run conduits in crawl space, under floor slab, as if exposed.

3.1.6.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use outdoors.

3.1.6.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40 and PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms.

(2) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(3) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

(4) Do not use, except where specifically indicated to be allowed.

3.1.6.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.6.5 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40. Convert nonmetallic conduit to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum 6 inches above floor.

3.1.6.8 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.6.9 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab.

3.1.6.11 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.6.12 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.6.13 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.6.14 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.6.15 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2 inch diameter. Provide liquidtight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.7 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways and when specifically indicated. Boxes in other locations: sheet steel. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. Threaded studs driven in by powder charge and provided with lock washers and nuts or nail-type nylon anchors may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.7.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of 4 inches square by 2 1/8 inches deep.

3.1.7.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.7.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

3.1.8 Mounting Heights

Mount panelboards, enclosed circuit breakers, and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Wall-mounted telecommunications outlets: mounted at height 60 inches above finished floor indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.9 Not used.

3.1.10 Not used.

3.1.11 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with Section 23 09 23.13 20 BACNET DIRECT CONTROL SYSTEMS FOR HVAC.

3.1.11.1 Marking Strips

Provide marking strips in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.12 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.13 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.14 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.15 Grounding and Bonding

Provide in accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.15.1 Ground Rods

Provide cone pointed ground rods. Measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, additional rods, spaced on center, not less than twice the distance of the length of the rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or

other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.15.3 Resistance

Maximum resistance-to-ground of grounding system: do not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.16 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.17 Government-Furnished Equipment

Contractor make connections to Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.18 Demolition of Existing Work

Perform demolition of existing electrical distribution systems as follows:

3.1.18.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.18.2 Existing Concealed Wiring to be Removed

Disconnect existing concealed wiring to be removed from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

3.1.18.3 Removal of Existing Electrical Distribution System

Removal of existing electrical distribution system equipment includes equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings, back to equipment's power source.

3.1.18.4 Continuation of Service

Maintain continuity of existing circuits of equipment to remain. Maintain existing circuits of equipment energized. Restor circuits wiring and power which are to remain but were disturbed during demolition back to original condition.

3.1.19 Watthour Meters

ANSI C12.1

3.1.20 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting: as specified in Section 09 90 00 PAINTS AND COATINGS. Where field painting of enclosures for panelboards, or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days' notice prior to each test.

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance: 250,000 ohms.

3.5.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NEA ATS. Measure primary and secondary voltages for independent testing firm or independent electrical consulting firm.

3.5.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.

3.5.5 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for

resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.5.6 Watthour Meter

a. Visual and mechanical inspection

(1) Examine for broken parts, shipping damage, and tightness of connections.

(2) Verify that meter type, scales, and connections are in accordance with approved shop drawings.

b. Electrical tests

(1) Determine accuracy of meter.

(2) Calibrate watthour meters to one-half percent.

(3) Verify that correct multiplier has been placed on face of meter, where applicable.

-- End of Section --

SECTION 26 51 00

INTERIOR LIGHTING
05/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2011) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A641/A641M	(2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM D4674 REV A	(2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY (IES)

IES LM-79	(2008) Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM-80	(2015) Measuring Lumen Maintenance of LED Light Sources
IES RP-16	(2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering
IES TM-21	(2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015; INT 12 2016) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2015) American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA SSL 1	(2010) Electronic Drivers for Led Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA WD 1	(1999; R 2015) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2015; ERTA 2015) Life Safety Code
NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment
UL 844	(2012) Standard for Luminaires for Use in Hazardous (Classified) Locations
UL 8750	(2009; Reprint May 2014) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment
UL 924	(2006; Reprint Dec 2015) Standard for Emergency Lighting and Power Equipment
UL 94	(2013; Reprint Jan 2016) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires or luminaire accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories mounted on exterior surfaces of buildings are specified in Section 26 56 00 EXTERIOR LIGHTING.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100 and IES RP-16.

b. For fluorescent, HID and induction luminaire light sources, "Average Rated Life" is the time after which 50 percent of a large group of light sources will have failed and 50 percent will have survived under normal conditions.

c. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also know as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

d. For fluorescent, HID and induction luminaires, "Luminaire Efficacy Rating" (LER) is the appropriate measure of energy efficiency, measured in lumens/watt. Specifically it is the luminaire's efficiency multiplied by the total rated light source lumens and the ballast factor, divided by the luminaire input watts.

e. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

f. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.4.1 Shop Drawings

Luminaire Drawings; G

Occupancy/Vacancy Sensor Coverage Layout; G

1.4.2 Product Data

Luminaires; G

Light Sources; G
Drivers, G

LED Luminaire Warranty; G

Luminaire Design Data; G

Vacancy Sensors; G

1.4.3 Test Reports

LED Luminaire - IES LM-79 Test Report; G

LED Light Source - IES LM-80 Test Report; G

LED Light Source - IES TM-21 Test Report; G

Occupancy/Vacancy Sensor Verification Tests; G

Energy Efficiency; G

1.4.4 Certificates

Luminaire Useful Life Certificate; G

LED Driver and Dimming Switch Compatibility Certificate; G

1.5 QUALITY CONTROL

1.5.1 Luminaire Drawings

Include dimensions, accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data must accompany shop drawings.

1.5.2 Occupancy/Vacancy Sensor Coverage Layout

Provide floor plans showing coverage layouts of all devices using manufacturer's product information.

1.5.3 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices.

1.5.4 Luminaire Design Data

a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified per the NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and

include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

b. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections must be obtained from testing in accordance with IES LM-80.

1.5.5 LED Luminaire - IES LM-79 Test Report

Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in IES LM-79.

1.5.6 LED Light Source - IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under "8.0 Test Report" in IES LM-80.

1.5.7 LED Light Source - IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in IES TM-21.

1.5.8 Occupancy/Vacancy Sensor Verification Tests

Submit test report outlining post-installation coverage and operation of sensors.

1.5.9 Test Laboratories

Test laboratories for the IES LM-79 and IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.

b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List at for LM-79 testing.

c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.5.10 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated.

1.5.11 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period must include applications of equipment and materials under similar circumstances and of similar size. The

product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.11.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.11.2 Material and Equipment Manufacturing Date

Products manufactured more than six months prior to date of delivery to site must not be used, unless specified otherwise.

1.5.11.3 Energy Efficiency

Submit data indicating lumens per watt efficacy and color rendering index of light source.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 LED Luminaire Warranty

a. Provide a written 10 year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

(1) Include finish warranty to include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All drivers.

(b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Provide the Contracting Officer with signed warranty certificates prior to final payment.

1.6.1.1 Provide Luminaire Useful Life Certificate

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be luminaires, luminaire controls, or associated equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires, luminaire controls, and associated equipment for exterior applications are specified in Section 26 56 00 EXTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

2.2.1 LED Luminaires

Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires. LED luminaires must meet the minimum requirements in the following table:

LUMINAIRE TYPE	MINIMUM LUMINAIRE EFFICACY (LE)	MINIMUM COLOR RENDERING INDEX (CRI)
LED TROFFER - 1 x 4300 x 1200 2 x 2600 x 600 2 x 4600 x 1200	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

LED luminaires must also meet the following minimum requirements:

a. Luminaires must have a minimum 10 year manufacturer's warranty.
b. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.

c. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.

e. Luminaires must be listed with the DesignLights Consortium 'Qualified Products List' when falling into category of "General Application" luminaires, i.e. Interior Directional, Display Case, Troffer, Linear Ambient, or Low/High Bay. Requirements are shown in the Designlights Consortium "Technical Requirements Table" at https://data.energystar.gov/dataset/EPA-Recognized-Laboratories-For-Lighting-Products/jgwf-7qrr.

f. Provide Department of Energy 'Lighting Facts' label for each luminaire.

2.2.5 Luminaires for Hazardous Locations

In addition to requirements stated herein, provide LED, luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

2.3 DRIVERS

2.3.1 LED Drivers

NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

a. Output power (watts)and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.

b. Power Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.

c. Current draw Total Harmonic Distortion (THD) of less than 20 percent.

d. Class A sound rating.

e. Operable at input voltage of 120-277 volts at 60 hertz.

f. Minimum 10 year manufacturer's warranty.

g. RoHS compliant.

h. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.

i. UL listed for dry or damp locations typical of interior installations.

j. Non-dimmable, step-dimmable to 50 percent output, or fully-dimmable using 0-10V control as indicated in luminaire schedule.

2.4 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type and wattage as indicated in luminaire schedule on project plans.

2.4.1 LED Light Sources

a. Correlated Color Temperature (CCT) of 4000 degrees K.

b. Minimum Color Rendering Index (CRI) R9 value of 80.

c. High power, white light output utilizing phosphor conversion (PC) process[or mixed system of colored LEDs, typically red, green and blue (RGB)].

d. RoHS compliant.

e. Provide light source color consistency by utilizing a binning tolerance within a 4 step McAdam ellipse.

2.5 LIGHTING CONTROLS

2.5.1 Toggle Switches

Provide line-voltage toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.5.3 Sensors for Lighting Control
IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A.

2.5.3.1 Occupancy Sensors

Provide occupancy sensors with coverage patterns as indicated on project plans. Provide no less quantity of sensors as shown on plans, but add additional sensors when required to fulfill coverage requirement for the specific model sensor provided. Sensor must be provided with an adaptive learning function that automatically sets sensor in optimum calibration in a set period of time after installation and a non-volatile memory that saves settings after a power outage. Provide sensors designed for ceiling, wall or wall-box installation as indicated. Operating voltage must be 120 volts. Provide housing of high-impact, injection-molded thermoplastic with a multi-segmented lens for PIR and dual technology sensors. Sensor operation requires movement to activate luminaires controlled, and turns luminaires off after a set time of inactivity.

2.5.3.1.1 Passive Infrared (PIR) Sensors

Provide ceiling or wall-mounted PIR sensors meeting the following requirements:

a. Temperature compensated, dual element sensor and a multi-element Fresnel lens (Poly IR4 material).

b. Technology to optimize automatic time delay to fit occupant usage patterns.

c. No minimum load requirement for line voltage sensors and be capable of switching from zero to 800 W at 120 VAC, 50/60 Hz and from zero to 1200 W at 277 VAC, 50/60 Hz. Control voltage sensors must not exceed a maximum load requirement of 20 mA at 24VDC.

d. Time delay of five to 30 minutes in increments of five minutes with a walk through and test mode set by DIP switch.

e. LED indicator that remains active during occupancy.

f. Built-in light level sensor that is operational from 0.8 to 18 lux (8 to 180 foot-candles).

g. Coverage pattern tested to NEMA WD 7 standards.

h. Standard five year warranty and be UL listed

i. No leakage current to load when in the off mode.

2.5.3.1.2 Ultrasonic Sensors

Provide ceiling-mounted ultrasonic sensors meeting the following requirements:

a. Operate at an ultrasonic frequency of 25 kHz.

b. LED on exterior of device to indicate occupant detection.

c. Adjustable time delay period of 15 seconds to 15 minutes.

d. UL listed with minimum five year warranty.

2.5.3.1.3 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the passive infrared or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.3.1.4 Power Packs for Sensors

UL 2043, CEC Title 24, ASHRAE 90.1 - IP. Power packs used to provide power to one or more lighting control sensors must meet the following requirements:

a. Input voltage - 120-277 VAC; output voltage - 24 VDC at 225 mA.

b. Plenum-rated, high-impact thermoplastic enclosure.

c. Utilizes zero-crossing circuitry to prevent damage from inrush current.

d. Maximum load rating of 16 amps for electronic lighting loads.

e. RoHS compliant.

2.5.3.2 Vacancy Sensors

Provide vacancy sensors as indicated above under paragraph OCCUPANCY SENSORS, but with requirement of a manual operation to activate luminaires controlled. Provide automatic operation to turn luminaires off after a set period of inactivity.

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 101, and NFPA 70 compliant.

2.6.1 Exit Signs
Provide exit signs consuming a maximum of five watts total.

2.6.1.1 LED Self-Powered Exit Signs

Provide with housing as scheduled. Provide 6 inch high, 3/4 inch stroke lettering on face of sign. Provide chevrons on either side of lettering to indicate direction. Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1 1/2 hours. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.

2.7 LUMINAIRE SUPPORT HARDWARE

2.7.1 Wire

ASTM A641/A641M; Galvanized, soft tempered steel, minimum 0.11 inches in diameter, or galvanized, braided steel, minimum 0.08 inches in diameter.

2.7. Threaded Rods

Threaded steel rods 3/16 inch diameter, zinc or cadmium coated.

2.8 EQUIPMENT IDENTIFICATION

2.8.1 Manufacturer's Namplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.8.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires must be clearly marked for operation of specific light sources and ballasts, generators or drivers. Note the following light source characteristics in the format "Use Only _____":

a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. Ballasts, generators or drivers must have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of NEMA 250 corrosion-resistance test.

2.10 RECESS- AND FLUSH-MOUNTED LUMINAIRES

Provide access to lamp and ballast from bottom of luminaire. Provide trim and lenses for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications.

2.11 SUSPENDED LUMINAIRES

Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers. Provide with swivel hangers to ensure a plumb installation. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers must allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended luminaires must have twin-stem hangers. Multiple-unit or continuous row luminaires must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Provide rods in minimum 0.18 inch diameter.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein. Install luminaires and lighting controls to meet the requirements of ASHRAE 90.1 - IP and ASHRAE 189.1.

To encourage consistency and uniformity, install luminaires of the same manufacture and model number when residing in the same facility or building.

3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature, color rendering index, and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

3.1.2 Luminaires

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Installation must meet requirements of NFPA 70. Mounting heights specified or indicated must be to the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed luminaires must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire and located near each corner of the luminaire. Ceiling grid clips are not allowed as an alternative to independently supported luminaires. Round luminaires or luminaires smaller in size than the ceiling grid must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around. Do not support luminaires by acoustical tile ceiling panels. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire. Provide wires, straps, or rods for luminaire support in this section. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

3.1.3 Suspended Luminaires

Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level. Locate so that there are no obstructions within the 45 degree range in all directions. The stem, canopy and luminaire must be capable of 45 degree swing. Pendants, rods, or chains 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation. Suspended luminaires in continuous rows must have internal wireway systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints. Support steel luminaires to prevent "oil-canning" effects. Luminaire finishes must be free of scratches, nicks, dents, and warps, and must match the color and gloss specified. Match supporting pendants with supported luminaire. Aircraft cable must be stainless steel. Canopies must be finished to match the ceiling and must be low profile unless otherwise shown. Maximum distance between suspension points must be 10 feet or as recommended by the manufacturer, whichever is less.

3.1.4 Power Supplies

Typically, provide power supplies (drivers) integral to luminaire as constructed by the manufacturer.

3.1.5 Exit Signs and Emergency Lighting Units

Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

3.1.6 Occupancy/Vacancy Sensors

Provide testing od sensor coverage in all spaces where sensors are placed. This should be done only after all furnishings (carpet, furniture, workstations, etc.) have been installed. Provide quantity of sensor units

indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage must provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage.

3.2 FIELD APPLIED PAINTING

Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

SECTION 26 56 00

EXTERIOR LIGHTING
05/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2013; INT 1 2013; Errata 1-3 2013; Errata 4-6 2014; Errata 7-8 2015; INT 2-3 2015) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus

ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10	(2011) IES Lighting Handbook
IES LM-79	(2008) Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM-80	(2015) Measuring Lumen Maintenance of LED Light Sources
IES RP-16	(2010; Addendum A 2008; Addenda B & C 2009) Nomenclature and Definitions for Illuminating Engineering
IES TM-15	(2011) Luminaire Classification System for Outdoor Luminaires
IES TM-21	(2011) Projecting Long Term Lumen Maintenance of LED Light Sources

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012; Errata 2012; INT 1-4 2012; INT 5-7 2013; INT 8-10 2014; INT 11 2015) National Electrical Safety Code

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2015) American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting Products
NEMA C136.31	(2010) American National for Roadway and Area Lighting Equipment - Luminaire Vibration
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA IEC 60529	(2004) Degrees of Protection Provided by Enclosures (IP Code)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 1310	(2011; Reprint Dec 2014) UL Standard for Safety Class 2 Power Units
UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 8750	(2009; Reprint May 2014) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Luminaires and accessories installed in interior of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings shall be as defined in IEEE 100 and IES RP-16.

b. For HID, fluorescent, and induction luminaire light sources, "Average Rated Life" is the time after which 50 percent of a large group of light sources will have failed and 50 percent will have survived under normal operating conditions.

c. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with the contract:

1.4.1 Preconstruction Submittals

LED Luminaire Warranty; G

1.4.2 Shop Drawings

Luminaire drawings; G

1.4.3 Product Data

LED Luminaires; G

Luminaire Light Sources; G

Luminaire Power Supply Units and Drivers; G

Time switch; G

Motion Sensor; G

Photocell; G

1.4.4 Samples

LED

Submit one sample of each luminaire type, complete with light source and ballast, generator or power supply unit. Sample will be returned to the Contractor for installation in the project work.

1.4.5 Design Data

Design Data for luminaires; G

1.4.6 Test Reports

LED Luminaire - IES LM-79 Test Report; G

LED Light Source - IES LM-80 Test Report; G

Submit operating test results as stated in paragraph entitled "Field Quality Control."

1.4.7 Certificates

Luminaire Useful Life Certificate; G

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life shall be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions shall be taken into consideration.

1.5 QUALITY ASSURANCE

1.5.1 Drawing Requirements

1.5.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and[computerized] candlepower distribution data shall accompany shop drawings.

1.5.2 Design Data for Luminaires

a. Provide distribution data according to IES classification type as defined in IES HB-10.

b. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections shall be obtained from testing in accordance with IES LM-80.

1.5.3 LED Luminaire - IES LM-79 Test Report

Submit test report on manufacturer's standard production model luminaire. Submittal shall include all photometric and electrical measurements, as well as all other pertinent data outlined under "14.0 Test Report" in IES LM-79.

1.5.4 LED Light Source - IES LM-80 Test Report

Submit report on manufacturer's standard production LED package, array, or module. Submittal shall include:

a. Testing agency, report number, date, type of equipment, and LED light source being tested.

b. All data required by IES LM-80.

1.5.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these

publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires for a minimum of 15 years. Products shall have been in satisfactory commercial or industrial use for 15 years prior to bid opening. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 15-year period.

1.5.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 LED Luminaire Warranty

Provide Luminaire Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

   1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

   2. Material warranty shall include:

      (a) All power supply units (drivers).

(b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Luminaires and associated equipment and accessories for interior applications are specified in Section 26 51 00 INTERIOR LIGHTING.

2.2 LED LUMINAIRES

UL 1598, NEMA C82.77 and UL 8750. Provide luminaires as indicated in luminaire schedule and XL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. All luminaires of the same type shall be provided by the same manufacturer.

2.2.1 General Requirements

a. LED luminaire housings shall be die cast or extruded aluminum. Housings for luminaires other than LED shall be die cast, extruded, or fabricated aluminum. Fabricated aluminum housings shall have all seams and corners internally welded to resist weathering, moisture and dust.

b. LED luminaires shall be rated for operation within an ambient temperature range of minus 30 degrees C (minus 22 degrees F) to 40 degrees C (104 degrees F).

c. Luminaires shall be UL listed for wet locations per UL 1598. Optical compartment for LED luminaires shall be sealed and rated a minimum of IP65 per NEMA IEC 60529.

d. LED luminaires shall produce a minimum efficacy as shown in the following table, tested per IES LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

Application	Luminaire Efficacy in Lumens per Watt
Exterior Wall-Mounted Area Luminaires	60
Bollards	35

e. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

f. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

g. Luminaires shall not exceed the following IES TM-15 Backlight, Uplight and Glare (B.U.G.) ratings:

1. Maximum Backlight (B) rating shall be determined by lighting zone in which luminaire is placed.

2. Maximum Uplight (U) rating shall be U0.

3. Maximum Glare (G) rating shall be determined by lighting zone in which luminaire is placed.

h. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

i. The finish color shall be as indicated in the luminaire schedule or detail on the project plans.

j. Luminaire lenses shall be constructed of clear tempered glass or UV-resistant acrylic.

k. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, ballasts, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

l. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

m. Luminaire must pass 3G vibration testing in accordance with NEMA C136.31.

n. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

2.2.2 Luminaire Light Sources

2.2.2.1 LED Light Sources

a. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

Nominal CCT: 4000 degrees K: 3985 plus or minus 275 degrees K

b. Color Rendering Index (CRI) shall be:

Greater than or equal to 70 for 4000 degrees K light sources.

c. Color Consistency:

Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.2.3 Luminaire Power Supply Units (Drivers)

2.2.3.1 LED Power Supply Units (Drivers)

UL 1310. LED Power Supply Units (Drivers) shall meet the following requirements:

a. Minimum efficiency shall be 85 percent.

b. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.

c. Shall be rated to operate between ambient temperatures of minus 30 degrees C (minus 22 degrees F) and 40 degrees C (104 degrees F)[50 degrees C (122 degrees F)].

d. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.

e. Operating frequency shall be: 50 or 60 Hz.

f. Power Factor (PF) shall be greater than or equal to 0.90.

g. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.

h. Shall meet requirements of 47 CFR 15, Class B.

i. Shall be RoHS-compliant.

j. Shall be mounted integral to luminaire. Remote mounting of power supply is not allowed.

k. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.

2.2.4 LED Luminaire Surge Protection

Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

2.3 EXTERIOR LUMINAIRE CONTROLS

Controls shall comply with ASHRAE 90.1 - IP.

2.3.1 Timeswitch

Timeswitch shall be an electronic type with a 7 day astronomic programming function that changes on/off settings according to seasonal variations of sunset and sunrise, providing a total of 56 on/off set points. Digital clock display format shall be AM/PM 12 hour type. Provide power outage backup for switch utilizing a lithium battery which provides coverage for a minimum of 7 days. Timeswitch shall provide control to channels or loads. Contacts shall be rated for 30 amps at 120-277 VAC resistive load in a DPST normally open (NO) configuration. Provide switch with manual bypass or remote override control, daylight savings time automatic adjustment module.

Timeswitch shall be housed in a surface-mounted, lockable NEMA 1 enclosure constructed of painted steel or plastic polymer conforming to NEMA ICS 6.

2.4 EQUIPMENT IDENTIFICATION

2.4.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.4.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific light sources and ballasts according to proper light source type. The following light source characteristics shall be noted in the format "Use Only _____":

a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place.

2.5 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 GROUNDING

Ground noncurrent-carrying parts of equipment including metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.1.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --`

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM
08/11

PART 1 GENERAL

1.1 RELATED SECTIONS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

Section 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

1.2 SUMMARY

1.2.1 Scope

a. This work includes completion of design and providing a new, complete, fire alarm and mass notification system as described herein and on the contract drawings for the building 8040. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system complete and ready for operation.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required provisions of NFPA 72, ISO 7240-16, IEC 60268-16, except as modified herein. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170. Final quantity, system layout, and coordination are the responsibility of the Contractor.

c. Each remote fire alarm control unit shall be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2009; R 2014) Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

ASME INTERNATIONAL (ASME)

ASME A17.1/CSA B44	(2013) Safety Code for Elevators and Escalators

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60268-16	(2003; ED 4.0) Sound System Equipment - Part 16: Objective Rating Of Speech Intelligibility By Speech Transmission Index

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7240-16	(2007) Fire Detection And Alarm Systems – Part 16: Sound System Control And Indicating Equipment
ISO 7240-19	(2007) Fire Detection and Alarm Systems – Part 19: Design, Installation, Commissioning and Service of Sound Systems for Emergency Purposes

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 170	(2015) Standard for Fire Safety and Emergency Symbols
NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02	(2010) Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems
UFC 4-021-01	(2008; with Change 1) Design and O&M: Mass Notification Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 90	Private Land Mobile Radio Services

UNDERWRITERS LABORATORIES (UL)

UL 1480	(2016) Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
UL 1638	(2016) Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling
UL 1971	(2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired
UL 2017	(2008; Reprint Jan 2016) General-Purpose Signaling Devices and Systems
UL 268	(2016) Smoke Detectors for Fire Alarm Systems
UL 464	(2016) Standard for Audible Signal Appliances
UL 521	(1999; Reprint Apr 2015) Heat Detectors for Fire Protective Signaling Systems
UL 864	(2014) Standard for Control Units and Accessories for Fire Alarm Systems
UL Electrical Constructn	(2012) Electrical Construction Equipment Directory
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions shall be defined as follows:

1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm Control Unit and Mass Notification Autonomous Control Unit (FMCP)

A master control panel having the features of a fire alarm and mass notification control unit and fire alarm and mass notification control units are interconnected. The panel has central processing, memory, input and output terminals, and LCD, LED Display units.

1.4.3 Local Operating Console (LOC)

A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery or recorded and/or live messages, initiate strobe and textural visible appliance operation and other relayed functions.

1.4.4 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door that terminal strips are securely mounted.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Nameplates; G

Instructions; G

Wiring Diagrams; G

System Layout; G

System Operation; G

Notification Appliances; G

Amplifiers; G

SD-03 Product Data

Technical Data And Computer Software; G

Fire Alarm Control Unit and Mass Notification Control Unit (FMCP); G

LCD, LED Display Unit (VDU); G

Terminal Cabinets; G

Manual Stations; G

Transmitters (including housing); G

Batteries; G

Battery Chargers; G

Smoke Sensors; G

Heat Detectors; G

Notification Appliances; G

Addressable Interface Devices; G

Amplifiers; G

Tone Generators; G

Digitalized Voice Generators; G

Remote Fire Alarm/Mass Notification Control Units; G

Radio Transmitter and Interface Panels; G

Digital Alarm Communicator Transmitter (DACT); G

Local Operating Console (LOC); G

SD-05 Design Data

Battery Power; G

Battery Chargers; G

SD-06 Test Reports

Field Quality Control

Testing Procedures; G

Smoke Sensor Testing Procedures; G

SD-07 Certificates

Installer

Formal Inspection and Tests

Final Testing

SD-09 Manufacturer's Field Reports

System Operation; G

Fire Alarm/Mass Notification System

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G

Instruction of Government Employees; G

SD-11 Closeout Submittals As-

Built Drawings

1.6 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

a. Identification of programmable portions of system equipment and capabilities.

b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

c. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

d. Description of Fire Alarm and Mass Notification Control Panel equipment operation.

e. Description of auxiliary and remote equipment operations.

f. Library of application software.

g. Operation and maintenance manuals.

1.7 QUALITY ASSURANCE

Equipment and devices shall be compatible and operable with existing station fire alarm system and shall not impair reliability or operational functions of existing supervising station fire alarm system. The proprietary type Supervising Station (PSS) is located in building 5013.

a. Interpret reference to "authority having jurisdiction" to mean the Contracting Offices Designated Representative (COR).

b. The recommended practices stated in the manufacturer's literature or documentation shall be considered as mandatory requirements.

c. Devices and equipment for fire alarm service must be listed by UL Fire Prot Dir or approved by FM APP GUIDE.

1.7.1 Qualifications

1.7.1.1 Design Services

Installations requiring completion of installation drawings and specification or modifications of fire detection, fire alarm, mass notification system, fire suppression systems or mass notification systems shall require the services and review of a qualified engineer. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

a. A registered professional engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of four years work experience in fire protection engineering.

b. A registered professional engineer (P.E.) in fire protection engineering.

c. Registered Professional Engineer with verification of experience and at least five years of current experience in the design of the fire protection and detection systems.

1.7.1.2 Supervisor

NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system/mass notification system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.3 Technician

Fire Alarm Technicians with a minimum of four years of experience utilized to install and terminate fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.4 Installer

Fire Alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and panels. An electrician shall be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.5 Test Personnel

Fire Alarm Technicians with a minimum of eight years of experience (NICET Level III)utilized to test and certify the installation of the fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.6 Manufacturer's Representative

The fire alarm and mass notification equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training (NICET Level III)on the system being installed.

1.7.1.7 Manufacturer

Components shall be of current design and shall be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein.

1.7.2 Regulatory Requirements

1.7.2.1 Requirements for Fire Protection Service

Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

1.7.2.2 Fire Alarm/Mass Notification System

Furnish equipment that is compatible and is UL listed, FM approved, or listed by a nationally recognized testing laboratory for the intended use. All listings by testing laboratories shall be from an existing ANSI or UL published standard. Submit a unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information. Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

1.7.2.3 Fire alarm Testing Services or Laboratories

construct fire alarm and fire detection equipment in accordance with UL Fire Prot Dir, UL Electrical Constructn, or FM APP GUIDE.

1.8 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Submit annotated catalog data as required in the paragraph SUBMITTAL, in table format on the drawings, showing manufacturer's name, model, voltage, and catalog numbers for equipment and components. Submitted shop drawings

shall not be smaller than ISO A1. Also provide UL or FM listing cards for equipment provided.

2.1.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory, such as UL or FM Approvals, LLC (FM), and listed or approved for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least two years prior to bid opening.

2.1.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCPs

b. Automatic transmitter/transceiver

c. Terminal Cabinet

Furnish nameplate illustrations and data to obtain approval by the Contracting Officer before installation. Obtain approval by the Contracting Officer for installation locations. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.1.3 Keys

Keys and locks for equipment shall be identical. Provide not less than six keys of each type required. Master all keys and locks to a single key as required by the Installation Fire Department.

LOC is not permitted to be locked or lockable.

2.2 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment shall be listed for use under the applicable reference standards. Interfacing of Listed UL 864 or similar approved industry listing with Mass Notification Panels listed to UL 2017 shall be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control. If a field modification is needed, such as adding equipment like relays, the manufacturer of the panels being same or different brand from manufacturer shall provide the installing contractor for review and confirmation by the installing contractor. As part of the submittal documents, provide this information.

2.3 SYSTEM OPERATION

The Addressable Interior Fire Alarm and Mass Notification System shall be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864 , and UL 2017. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the control panel is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, or remotely from authorized locations/users.

Submit data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances, 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings. Submit a complete description of the system operation in matrix format on the drawings. Submit a complete list of device addresses and corresponding messages.

2.3.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textural)

a. Connect alarm initiating devices to initiating device circuits (IDC) Class "B" to signal line circuits (SLC) Class "B" and installed in accordance with NFPA 72.
b. Connect alarm notification appliances and speakers to notification appliance circuits (NAC) Class "B".

c. The system shall operate in the alarm mode upon actuation of any alarm initiating device or a mass notification signal. The system shall remain in the alarm mode until initiating device(s) or mass notification signal is/are reset and the control panel is manually reset and restored to normal. Audible, and visual appliances and systems shall comply with NFPA 72 and as specified herein. Fire alarm system/mass notification system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

2.3.2 Functions and Operating Features

The system shall provide the following functions and operating features:

a. The FMCP shall provide power, annunciation, supervision, and control for the system. Addressable systems shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. For Class "A" or "X" circuits with conductor lengths of 3m (10 feet) or less, the conductors shall be permitted to be installed in the same raceway in accordance with NFPA 72.

c. Provide signaling line circuits for each floor.

d. Provide signaling line circuits for the network.

e. Provide notification appliance circuits. The visual alarm notification appliances shall have the flash rates synchronized as required by NFPA 72.

f. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system

modules within the control panel.

g. Provide an audible and visual trouble signal to activate upon a single break or open condition, or ground fault (or short circuit for Class "X"). The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a trouble alarm silence feature that shall silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke sensor in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.

h. Provide program capability via switches in a locked portion of the FACP to bypass the automatic notification appliance circuits, air handler shutdown features. Operation of this programming shall indicate this action on the FACP display and printer output.

i. Alarm, supervisory, and/or trouble signals shall be automatically transmitted to the fire department..

j. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

k. The system shall be capable of being programmed from the panels keyboard. Programmed information shall be stored in non-volatile memory.

l. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.

m. There shall be no limit, other than maximum system capacity, as to the number of addressable devices, that may be in alarm simultaneously.

n. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as an HVAC system, the addressable fire alarm relay shall be in the vicinity of the emergency control device.

o. An alarm signal shall automatically initiate the following functions:

(1) Transmission of an alarm signal to the fire department.

(2) Visual indication of the device operated on the control panel (FACP/MNCP), and on the graphic annunciator. Indication on the graphic annunciator shall be by floor, zone or circuit, and type of device.

(3) Continuous actuation of all alarm notification appliances.

(4) Recording of the event via electronically in the history log of the fire control system unit.

Operation of a duct smoke sensor shall shut down the appropriate air handler in accordance with NFPA 90A in addition to other

requirements of this paragraph and as allowed by NFPA 72.

p. A supervisory signal shall automatically initiate the following functions:

(1) Visual indication of the device operated on the FACP, and on the graphic annunciator, and sound the audible alarm at the respective panel.

(2) Transmission of a supervisory signal to the fire department.

(3) Recording of the event electronically in the history log of the control unit.

q. A trouble condition shall automatically initiate the following functions:

(1) Visual indication of the system trouble on the FACP, and on the graphic annunciator, and sound the audible alarm at the respective panel.

(2) Transmission of a trouble signal to the fire department.

(3) Recording of the event in the history log of the control unit.

r. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACP is 10 seconds.

s. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

t. Activation of a LOC pushbutton shall activate the audible and visual alarms in the facility. The audible message shall be the one associated with the pushbutton activated.

2.4 SYSTEM MONITORING

2.4.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, shall be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address.

2.5 MASS NOTIFICATION SYSTEM FUNCTIONS

2.5.1 Notification Appliance Network

The audible notification appliance network consists of speakers located to provide intelligible instructions at areas as indicated. The Mass Notification System announcements shall take priority over all other audible announcements of the system including the output of the fire alarm system in a normal or alarm state. When a mass notification announcement is activated during a fire alarm, all fire alarm system functions shall

continue in an alarm state except for the output signals of the fire alarm audible and visual notification appliances.

2.5.2 Strobes

Provide strobes to alert hearing-impaired occupants.

2.5.3 Voice Notification

An autonomous voice notification control unit is used to monitor and control the notification appliance network and provide consoles for local operation. Using a console, personnel in the building can initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and optional textual message notification appliances. The autonomous voice notification control unit will temporarily override audible fire alarm notification while delivering Mass Notification messages to ensure they are intelligible.

2.5.4 Installation-Wide Control

If an installation-wide control system for mass notification exists on the base, the autonomous control unit shall communicate with the central control unit of the installation-wide system. The autonomous control unit shall receive commands/messages from the central control unit and provide status information.

2.6 OVERVOLTAGE AND SURGE PROTECTION

2.6.1 Signaling Line Circuit Surge Protection

For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62.41.1 and IEEE C62.41.2. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveform(s):

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each wireline circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection.

2.6.2 Sensor Wiring Surge Protection

Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms:

a. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a

peak current of 500 amperes. Fuses shall not be used for surge protection.

2.7 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored shall be configured as a Class "B" initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation, etc. The module shall be UL or FM listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.

2.8 ADDRESSABLE CONTROL MODULE

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL or FM listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Class "B" notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules shall be located in environmental areas that reflect the conditions to which they were listed.

2.9 ISOLATION MODULES

Provide isolation modules to subdivide each signaling line circuit into groups of not more than 20 addressable devices between adjacent isolation modules.

2.10 SMOKE SENSORS

2.10.1 Photoelectric Smoke Sensors

Provide addressable photoelectric smoke sensors as follows:

a. Provide analog/addressable photoelectric smoke sensors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke sensors shall be listed for use with the fire alarm control panel.

b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL listed as smoke-automatic fire sensors.

c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.

e. The sensor address shall identify the particular unit, its location within the system, and its sensitivity setting. Sensors shall be of the low voltage type rated for use on a 24 VDC system.

f. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device.

(1) Primary status

(2) Device type

(3) Present average value

(4) Present sensitivity selected

(5) Sensor range (normal, dirty, etc.)

2.10.2 Ionization Type Smoke Sensors

Provide addressable ionization type smoke sensors as follows:

a. Provide analog smoke sensors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion. Smoke sensors shall be listed for use with the fire alarm control panel.

b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL or FM listed as smoke-automatic fire sensors.

c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.

f. An operator at the control panel, having a proper access level, shall

have the capability to manually access the following information for each initiating device.

(1) Primary status

(2) Device type

(3) Present average value

(4) Present sensitivity selected

(5) Sensor range (normal, dirty, etc.)

(6) Sensitivity adjustments for smoke detectors.

2.10.3 Duct Smoke Sensors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. (It is not permitted to cut the duct insulation to install the duct detector directly on the duct). Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel.

a. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel.

b. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Remote indicators shall be provided where required by NFPA 72 and these shall be provided with test and reset switches.

c. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 to INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function shall be located within 3 feet of the controlled circuit or appliance. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.10.4 Smoke Sensor Testing

Smoke sensors shall be tested in accordance with NFPA 72 and manufacturer's recommended calibrated test method. Submit smoke sensor testing procedures for approval. In addition to the NFPA 72 requirements, smoke detector sensitivity shall be tested during the preliminary tests.

2.11 HEAT DETECTORS

2.11.1 Heat Detectors

Heat detectors shall be designed for detection of fire by fixed temperature. The alarm condition shall be determined by comparing sensor valve with the stored values. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, shall be types approved for such locations.

2.11.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication that is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F.The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 feet.

2.11.1.2 Rate Compensating Detectors

Detectors shall be surface mounted horizontal type, with outlet box supported independently of wiring connections. Detectors shall be hermetically sealed and automatically resetting. Rate Compensated detectors shall be rated for 50 by 50 feet.

2.11.1.3 Fixed Temperature Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 135 degrees F. The UL 521 test rating for the fixed temperature detectors shall be rated for 50 by 50 feet.

2.11.2 Self-Test Routines

Automatic self-test routines shall be performed on each sensor that will functionally check sensor sensitivity electronics and ensure the accuracy of the value being transmitted. Any sensor that fails this test shall indicate a trouble condition with the sensor location at the control panel.

2.11.3 Operator Access

An operator at the control panel, having the proper access level, shall have the capability to manually access the following information for each heat sensor:

a. Primary status

b. Device type

c. Present average value

d. Sensor range ()

2.11.4 Operator Control

An operator at the control panel, having the proper access level, shall have the capability to manually control the following information for each heat sensor:

a. Alarm detection sensitivity values

b. Enable or disable the point/device

c. Control sensors relay driver output

2.12 ELECTRIC POWER

2.12.1 Primary Power

Power shall be 120 VAC service for the FMCP from the AC service to the building in accordance with NFPA 72.

2.13 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

2.13.1 Batteries

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the FMCP. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.13.1.1 Capacity

Battery size shall be the greater of the following two capacities.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 24 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.13.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements.

(1) Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include ampere-hour requirements for each system component and each panel component, and compliance with UL 864.

(2) Provide complete battery calculations for both the alarm, alert, and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

(3) A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries.

b. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

2.13.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 120 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.14 FIRE ALARM CONTROL UNIT AND MASS NOTIFICATION CONTROL UNIT (FMCP)

Provide a complete control panel fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care and maintenance of the systems shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit cabinets shall match exactly.

a. Each control unit shall provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each panel with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit shall have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.

c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight pre-recorded messages. Provide the ability to automatically repeat pre-recorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, and initiate/synchronize strobes. Provide a complete set of

self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

2.14.1 Cabinet

Install control panel components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of panels as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Fire Alarm and Mass Notification Control Panel" and shall not be less than 1 inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

2.14.2 Control Modules

Provide power and control modules to perform all functions of the FACP. Provide audible signals to indicate any alarm, supervisory, or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and resistors, if any, on screw terminals in the FACP. Circuits operating at 24 VDC shall not operate at less than the UL listed voltage at the sensor or appliance connected. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage

2.14.3 Silencing Switches

2.14.3.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCP that shall silence the audible and visual. This switch shall be overridden upon activation of a subsequent alarm.

2.14.3.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervision, or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

2.14.4 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the FACP after the initiating device or devices have been restored to normal.

2.14.5 Audible Notification System

The Audible Notification System shall comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements ISO 7240-16, IEC 60268-16, except as specified herein. The system shall be

a two-way multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Audible appliances shall produce a temporal code 3 tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced. Automatic messages shall be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message shall override the automatic audible output through use of a microphone input at the control panel or the LOC.

a. When using the microphone, live messages shall be broadcast throughout a selected floor or floors or all call The system shall be capable of operating all speakers at the same time. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

b. The Mass Notification functions shall override the manual or automatic fire alarm notification or Public Address (PA) functions. Other fire alarm functions including transmission of a signal(s) to the fire department shall remain operational. The system shall have the capability of utilizing LOC with redundant controls of the notification system control panel. Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level. Amplifier outputs shall be not greater than 100 watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. A hand held microphone shall be provided and, upon activation, shall take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC Circuits activation.

2.14.5.1 Outputs and Operational Modules

All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Mass Notification event the panel shall not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

2.14.5.2 Mass Notification

a. Mass Notification functions shall take precedence over all other function performed by the Audible Notification System. Messages shall utilize a male voice and shall be similar to the following:

1) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"May I have your attention, please. A fire has been reported that may affect your floor. Please walk to the nearest exit and evacuate the building." (Provide a 2 second pause.)

(repeat the message continuously)

2) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is a Mass Notification System. Tornado warning, Immediately proceed to the designated tornado shelter.
DO NOT evacuate the building, Act now!"

(repeat message 2 times)

3) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is a Mass Notification System. Immediately evacuate the facility and proceed to the designated rally point."

(repeat message 2 times)

4) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is a Mass Notification System. Immediately proceed to the designated shelter in place area and conduct all shelter in place actions."

(repeat message 2 times)

5) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is a Mass Notification System. Initiate Force Protection Condition Charlie actions immediately."

(repeat message 2 times)

6) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is a Mass Notification System. Initiate Force Protection Condition Delta actions immediately.

(repeat message 2 times)

7) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is a Mass Notification System. All clear, repeat all clear, return to your normal duty location."

(repeat message 2 times)

8) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Attention, this is a Test of the Mass Notification System. Do not evacuate the building this is only a test."

(repeat message 2 times)

b. Include ALL installation specific message in this section.

c. The LOC shall incorporate a Push-To-Talk (PTT) microphone, redundant controls and system status indicators of/for the system. The unit shall incorporate microphone override of any tone generation or prerecorded messages. The unit shall be fully supervised from the control panel. The housing shall contain a latch (not lock).

d. Auxiliary Input Module shall be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface.

e. LOC shall incorporate a Push-To-Talk (PTT) microphone, and controls to allow Public Address paging in the facility. The Public Address paging function shall not override any alarm or notification functions and shall be disabled by such signals. The microphone shall be handheld style. All wiring to the LOC shall be supervised in accordance with UFC 4-021-01. Systems that require field modification or are not supervised for multiple LOC's shall not be approved.

f. When an installation has more than one LOC, the LOC's shall be programmed to allow only one LOC to be available for page or messaging at a time. Once one LOC becomes active, all other LOC's will have an indication that the system is busy (Amber Busy Light)and cannot be used at that time. This is to avoid two messages being given at the same time. Also, it must be possible to override or lockout the LOC's from the Master Command Panel (in accordance with NFPA 72.)

2.14.6 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.14.7 Field Programmability

Provide control units and control panels that are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

2.14.8 Input/Output Modifications

The FMCP shall contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel mounted keypad. Any bypass or modification to the system shall indicate a trouble condition on the FMCP.

2.14.9 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble

condition on the system still exists.

2.14.10 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

2.14.11 Walk Test

The FACP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

2.14.12 History Logging

In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.14.13 Remote LCD Text Display

An LCD text display shall be provided at locations as shown on the drawings. The size shall not exceed 16 inches length by 3 inches deep with a height necessary to meet the requirements of Chapter 24 of NFPA 72). The text display shall as a minimum meet the following requirements:

a. Two lines of information for high priority messaging.

b. Minimum of 20 characters per line (40 total) displayed.

c. Text shall be no less than height requirements in Table 24.4.2.20.14.5 of NFPA 72 and color/contrast requirements of 24.4.2.20 of NFPA 72.

d. 32K character memory.

e. Display shall be wall or ceiling mounted.

f. Mounting brackets for a convenient wall/cubicle mount.

g. During non-emergency periods, display date and time.

h. All programming shall be accomplished from the Mass Notification network. No user programming shall be required.

An LCD text display shall be provided at locations as shown on the drawings. The LCD text display shall spell out the words "EVACUATE" and "ANNOUNCEMENT" and the remainder of the emergency instructions. The design of LCD text display shall be such that it cannot be read when not illuminated.

2.15 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a remote FMCP, terminal cabinet, or in the FMCP. Submit data to indicate that the amplifiers have sufficient capacity to simultaneously drive all notification speakers at the maximum rating plus 50 percent spare capacity. Annotate data for each circuit on the drawings.

2.15.1 Operation

The system shall automatically operate and control all building speakers except those installed in the stairs and within elevator cabs. The speakers in the stairs and elevator cabs shall operate only when the microphone is used to deliver live messages.

2.15.2 Construction

Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.15.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and panel mounted microphone . Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.

2.15.4 Tone Generator

The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a code 3 temporal tone and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

2.15.5 Protection Circuits

Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified.

2.16 ANNUNCIATOR

2.16.1 Annunciator Panel

Provide an annunciator that includes an LCD display. The display shall indicate the device in trouble/alarm or any supervisory device. Display the device name, address, and actual building location.

A building floor plan shall be provided mounted (behind plexiglass or similar protective material) at the annunciator location. The floor plan shall indicate all rooms by name and number including the locations of stairs and elevators. The floor plan shall show all devices and their programmed address to facilitate their physical location from the LCD display information.

2.16.2 Programming

Where programming for the operation of the annunciator is accomplished by a separate software program than the software for the FMCP, the software program shall not require reprogramming after loss of power. The software shall be reprogrammable in the field.

2.17 MANUAL STATIONS

Provide metal or plastic, semi-flush mounted, double action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire-engine red with molded raised lettering operating instructions of contrasting color. The use of a key or wrench shall be required to reset the station.Manual stations shall be mounted at 44 inches. Stations shall have a separate screw terminal for each conductor.

2.18 NOTIFICATION APPLIANCES

2.18.1 Fire Alarm/Mass Notification Speakers

Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Surface mounted audible appliances shall be painted red. Recessed audible appliances shall be installed with a grill that is painted red.

a. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Tap settings shall include taps of 1/8, 1/4, 1/2, 1, and 2 watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 4 inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall mounted unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCP.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

c. Speakers shall utilize screw terminals for termination of all field wiring.

2.18.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Architectural Barriers Act (ABA). Colored lens, such as amber, shall comply with UL 1638. The manufacturer shall have the color lens tested to the full UL 1971 polar plotting criteria, voltage drop, and temperature rise as stated in 1971. Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and be marked "Fire" in red letters.Fire Alarm/Mass Notification Appliances shall have amber high intensity optic lens, xenon flash tubes, and output white light and be marked "ALERT" in red letters. The light pattern shall be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 15 candela (actual output after derating for tinted lens) based on the UL 1971 test. Strobe shall be surface mounted. Where more than two appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices shall use screw terminals for all field wiring.

2.19 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures shall be provided to permit Fire Alarm or Mass Notification components to be used in areas that exceed the environmental limits of the listing. The enclosure shall be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the UL category that the component is currently listed. Guards required to deter mechanical damage shall be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

2.20 INTERFACE TO THE BASE WIDE MASS NOTIFICATION NETWORK

2.20.1 Radio

The radio transceiver shall be bi-direction and meet all the requirements of paragraph, RADIO TRANSMITTER AND INTERFACE PANELS as specified in this Specification Section. The transceiver utilized in the Mass Notification System shall be capable of the following:

a. Communication with the Central Control/Monitoring System to provide supervision of communication link and status changes are reported by automatic and manual poll/reply/acknowledge routines.

b. All monitored points/status changes are transmitted immediately and at programmed intervals until acknowledged by the Central Control/Monitoring System.

c. Each transceiver shall transmits a unique identity code as part of all messages; the code is set by the user at the transceiver.

2.20.1.1 Radio Frequency Communications

Use of radio frequency-type communications systems shall comply with National Telecommunications and Information Administration (NTIA)

requirements.

2.20.1.2 Licensed Radio Frequency Systems

An approved DD Form 1494 for the system is required prior to operation.

2.21 AUTOMATIC FIRE TRANSMITTERS

2.21.1 Radio Transmitter and Interface Panels

Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is Monaco and the transceiver shall be fully compatible with this equipment. At the contractors option, and if UL or FM listed, the transmitter may be housed in the same panel as the fire alarm control panel. The transmitter shall be Narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.21.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic.

2.21.1.2 Battery Power

Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.21.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing shall contain a lock that is keyed identical to the fire alarm system for the building. Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.21.1.4 Antenna

Antenna shall be omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

2.21.2 Signals to Be Transmitted to the Base Receiving Station

The following signals shall be sent to the base receiving station:

a. Sprinkler water flow

b. Manual pull stations

c. Smoke detectors

d. Duct smoke detectors

f. Heat detectors

h. Sprinkler valve supervision

2.22 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein. NFPA 70 accepted fire alarm cables that do not require the use of raceways except as modified herein are permitted.

2.22.1 Alarm Wiring

The SLC wiring shall be solid copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. 14 AWG size twisted and shielded solid conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, shall be solid copper No. 14 AWG size conductors at a minimum. Speaker circuits shall be copper No. 16 AWG size twisted and shielded conductors at a minimum. Wire size shall be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC shall not operate at less than the UL listed voltages for the sensors and/or appliances. Power wiring, operating at 120 VAC minimum, shall be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables shall comply with NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION OF FIRE ALARM INITIATING DEVICES AND NOTIFICATION APPLIANCES

3.1.1 FMCP

Locate the FMCP where indicated on the drawings. Surface mount the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at 5 feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FMCP.

3.1.2 Manual Stations:

Locate manual stations as required by NFPA 72 and as indicated on the drawings. Mount stations so that their operating handles are 4 feet above

the finished floor. Mount stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally.

3.1.3 Notification Appliance Devices

Locate notification appliance devices as required by NFPA 72. Mount assemblies on walls as required by NFPA 72 and to meet the intelligibility requirements. Ceiling mounted speakers shall conform to NFPA 72.

3.1.4 Smoke and Heat Sensors

Locate sensors as required by NFPA 72 and their listings on a 4 inch mounting box. Locate smoke and heat sensors on the ceiling. Install heat sensors not less than 4 inches from a side wall to the near edge. Heat sensors located on the wall shall have the top of the sensor at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke sensors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. In raised floor spaces, install the smoke sensors to protect 225 square feet per sensor. Install smoke sensors no closer than 5 feet from air handling supply outlets.

3.1.5 Annunciator

Locate the annunciator as shown on the drawings. Surface mount the panel, with the top of the panel 6 feet above the finished floor or center the panel at 5 feet, whichever is lower.

3.1.6 Water Flow Detectors and Tamper Switches

Connect to water flow detectors and tamper switches.

3.1.7 Local Operating Console (LOC)

Locate the LOC as required by NFPA 72 and as indicated. Mount the console so that the top message button is no higher than 44 inches above the floor.

3.2 SYSTEM FIELD WIRING

3.2.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Conform wiring to NFPA 70.

Indicate the following in the wiring diagrams.

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.2.2 Terminal Cabinets

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size shall be appropriate for the size of the wiring to be connected. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted.

3.2.3 Alarm Wiring

Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays.

Use of cables that do not require a raceway as stated hereinbefore are permitted; install them in accordance with NFPA 70. Protect any exposed (as defined in NFPA 70) cables against physical damage by the use of magnetic raceways which shall also be red colored. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, that is in or adjacent to the FMCP. Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. Color coding is required for circuits and shall be maintained throughout the circuit. Conductors used for the same functions shall be similarly color coded. Conform wiring to NFPA 70.

3.2.4 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCP, and remote FMCP and the LOC shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCP, and remote FMCP shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.3 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

Maintain existing fire alarm equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it shall be placed in service and connected to the station fire alarm system. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.

b. Disconnect and remove the existing fire alarm and smoke detection systems where indicated and elsewhere in the specification.

c. Control panels and fire alarm devices and appliances disconnected and removed shall be turned over to the Contracting Officer.

d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.

3.4 CONNECTION OF NEW SYSTEM

The following new system connections shall be made during the last phase of construction, at the beginning of the preliminary tests. New system connections shall include:

a. Connection of new control modules to existing magnetically held smoke door (hold-open) devices.

b. Connection of new elevator recall smoke sensors to existing wiring and conduit.

c. Connection of new system transmitter to existing base fire reporting system.

Once these connections are made, system shall be left energized and new audio/visual devices deactivated. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

3.5 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire rated walls, partitions with fire rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.6 PAINTING

Paint exposed electrical, fire alarm conduit, and surface metal raceway to match adjacent finishes in exposed areas. Paint junction boxes red in unfinished areas and conduits and surface metal raceways shall be painted with a 1-inch wide red band every 10 feet in unfinished areas.. Painting shall comply with Section 09 90 00 PAINTS AND COATINGS.

3.7 FIELD QUALITY CONTROL

3.7.1 Testing Procedures

Submit detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, and signed by representative of the installing company, for the fire detection and alarm system 60 days prior to performing system tests. Detailed test procedures shall list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, Guard's Tour equipment, and transient (surge) suppressors. Test

procedures shall include sequence of testing, time estimate for each test, and sample test data forms. The test data forms shall be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72) and shall be used for the preliminary testing and the acceptance testing. The test data forms shall record the test results and shall:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how this test shall be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for testing smoke detectors using real smoke).

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.2 Tests Stages

3.7.2.1 Preliminary Testing

Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

3.7.2.2 Request for Formal Inspection and Tests

When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contracting Offices Designated Representative (COR).

3.7.2.3 Final Testing

Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. Furnish instruments and personnel required for the tests. A

final acceptance test will not be scheduled until the following are provided at the job site:

a. The systems manufacturer's technical representative

b. Marked-up red line drawings of the system as actually installed

c. Megger test results

d. Loop resistance test results

e. Complete program printout including input/output addresses

The final tests will be witnessed by the Contracting Offices Designated Representative (COR). At this time, any and all required tests shall be repeated at their discretion.

3.7.2.4 System Acceptance

Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings shall show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings shall be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings shall be provided at the time of, or prior to the final acceptance test.

a. Furnish one set of CD or DVD discs containing software back-up and CAD based drawings in latest version of AutoCAD and DXF format of as-built drawings and schematics.

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

3.7.3 Minimum System Tests

Test the system in accordance with the procedures outlined in NFPA 72, ISO 7240-16, IEC 60268-16. The required tests are as follows:

a. Megger Tests:After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

b. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

c. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.

d. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

e. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72 except that, for item 12(e) (Supervision) in Table 14.4.2.2, disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision shall be tested at each device.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided to the Contracting Officer.

l. Verify that red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke sensors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke sensors shall be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

3.7.3.1 Intelligibility Tests

Intelligibility testing of the System shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2. Following are the specific requirements for intelligibility tests:

a. Intelligibility Requirements: Verify intelligibility by measurement

after installation.

b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .7 .

c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the DOD installation, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.

d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value shall be measured on the floor or other walking surface as follows:

(1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

(2) Curving around any corners or obstructions, with a 12 inches clearance there from.

(3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.8 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.8.1 Instructor

Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm and fire detection system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.8.2 Required Instruction Time

Provide 8 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.

3.8.2.1 Technical Training

Equipment manufacturer or a factory representative shall provide 1 days of on site and 5 days of technical training to the Government at the manufacturing facility. Training shall allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises. Factory training shall occur within 6 months of system acceptance.

3.9 Technical Data and Computer Software

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize designated government personnel with proper operation of the installed system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.10 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Submit 6 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package. Manuals shall be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions shall include:

a. "Manufacturer Data Package 5" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software delivered for this project shall be provided, on each type of CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference. All data (devices, testing frequencies, etc.) shall comply with UFC 3-601-02.

3.11 EXTRA MATERIALS

3.11.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system shall be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During guarantee period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

3.11.2 Interchangeable Parts

Spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the Contracting Officer at the time of the final acceptance testing.

3.11.3 Spare Parts

Furnish the following spare parts and accessories:

a. Four fuses for each fused circuit

b. Two of each type of notification appliance in the system (e.g. speaker, FA strobe, MNS strobe, etc.)

c. Two of each type of initiating device included in the system (e.g. smoke detector, thermal detector, manual station, etc.)

3.11.4 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer.

-- End of Section --

SECTION 31 23 00.00 20

EXCAVATION AND FILL
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 139/A 139M	(2004) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A 252	(1998; R 2002) Standard Specification for Welded and Seamless Steel Pipe Piles
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2321	(2005) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft.)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety -- Safety and Health Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004	(1993; Rev O; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)
EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

1.2 DEFINITIONS

1.2.1 Degree of Compaction

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, for general soil types, abbreviated as percent laboratory maximum density.

1.2.2 Hard Materials

Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.3 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 00700 GENERAL:

1.3.1 Preconstruction Submittals

Shoring and Sheeting Plan; G

Submit 15 days prior to starting work.

1.3.2 Test Reports; G

Fill and backfill test

Select material test

Density tests

Moisture Content Tests

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

1.4 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of materials.

1.5 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Bedding material in the quantities required is not available on Government property.
b. Blasting will not be permitted. Remove material in an approved manner.

1.6 REQUIREMENTS FOR OFF SITE SOIL

Soils brought in from off site for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCPL test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA 530/F-93/004 Method 5030/8020. TCLP shall be performed in accordance with EPA 530/F-93/004 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Material shall not be brought on site until tests have been approved by the Contracting Officer.

1.7 QUALITY ASSURANCE

1.7.1 Shoring and Sheeting Plan

Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

1.7.2 Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Excavation made with power-driven equipment is not permitted within 5 feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Satisfactory Materials

Any materials classified by ASTM D 2487 as GW, GP, and SW, free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. Unless specified otherwise, the maximum particle diameter shall be one-half the lift thickness at the intended location.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 3 inches. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are nonplastic (plasticity index equals zero). Materials classified as GM and SM will be identified as cohesive only when the fines have a plasticity index greater than zero.

2.1.4 Backfill and Fill Material

ASTM D 2487, classification GW, GP, GM, SW, SP, SM, with a maximum ASTM D 4318 liquid limit of 35, maximum ASTM D 4318 plasticity index of 12, and a maximum of 25 percent by weight passing ASTM D 1140, No. 200 sieve.

2.1.5 Topsoil

Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

2.2 UTILITY BEDDING MATERIAL

2.2.1 Sand

Clean, medium-grained sand classified as aggregate for masonry mortar by ASTM C 144.

2.3 INITIAL BACKFILL MATERIAL

Clean, medium-grained sand classified as aggregate for masonry mortar by ASTM C 144.

2.4 BORROW

Obtain borrow materials required in excess of those furnished from excavations from sources outside of Government property.

2.5 MATERIAL FOR PIPE CASING

2.5.1 Casing Pipe

ASTM A 139/A 139M, Grade B, or ASTM A 252, Grade 2, smooth wall pipe. Casing size shall be of the outside diameter and wall thickness as indicated. Protective coating is not required on casing pipe.

2.5.2 Spacers

Spacers shall be as indicated.

2.6 BURIED WARNING AND IDENTIFICATION TAPE

Metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes

Blue: Water Systems

Red: Electric

2.6.1 Detectable Warning Tape for Non-Metallic Piping

Gas: Yellow

Communications: Orange

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.7 DETECTION WIRE FOR NON-METALLIC PIPING

Detection wire shall be insulated single strand, solid copper, minimum size 10 AWG.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Shoring and Sheeting

Provide shoring bracing, cribbing, trench boxes, underpinning and sheeting as required by Section 25A and B of EM 385-1-1 (USACE). In addition to Section 25 A and B of EM 385-1-1, include provisions in the shoring and sheeting plan that will accomplish the following:

a. Prevent undermining of pavements, foundations and slabs.
b. Prevent slippage or movement in banks or slopes adjacent to the excavation.

c. Allow for the abandonment of shoring and sheeting materials in place in critical areas as the work is completed. In these areas, backfill the excavation to within 3 feet of the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

d. The Contractor may slope the faces of excavations in lieu of providing shoring where all the following conditions are met:

1. The excavation is less than 20 feet in depth.

2. There are no adjacent structures, roads, or pavements that will affect the excavation.

3. No equipment, stored material, or overlying material will affect the excavation.

4. Vibration from equipment, traffic, or blasting will not affect the excavation.

5. There will be no ground water problems.

6. Surcharges will not affect the excavation.

7. Station operational considerations permit laying back the slopes of the excavation.

3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils, prevent erosion and undermining of foundations. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.1.2.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 2 feet below the working level.

Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly.

3.1.3 Underground Utilities

Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction.

3.1.4 Machinery and Equipment

Movement of construction machinery and equipment over pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.2 SURFACE PREPARATION

3.2.1 Clearing and Grubbing

Unless indicated otherwise, remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations within lines 5 feet each side of pipeline centerline. Remove stumps entirely. Grub out matted roots and roots over 2 inches in diameter to at least 18 inches below existing surface.

3.2.2 Stripping

Strip suitable soil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be stockpiled and used for backfilling. Locate topsoil so that the material can be used readily for the finished grading. Where sufficient existing topsoil conforming to the material requirements is not available on site, provide borrow materials suitable for use as topsoil. Protect topsoil and keep in segregated piles until needed.

3.3 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed. Refill with satisfactory material and compact to 95 percent of ASTM D 1557 maximum density. Unless specified otherwise, refill excavations cut below indicated depth with satisfactory material and compact to 95 percent of ASTM D 1557 maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced with satisfactory materials to the indicated excavation grade. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

3.3.1 Pipe Trenches

Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

3.3.2 Hard Material and Rock Excavation

Remove hard material and rock to elevations indicated in a manner that will leave base material in an unshattered and solid condition.

3.3.3 Excavated Materials

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Paragraph "DISPOSITION OF SURPLUS MATERIAL."

3.4 BEDDING

Provide sand bedding in the bottom of all pipe trenches. The bedding shall be a uniform 3" thickness after being compacted to 95% of the modified procter. Recesses shall be excavated to accommodate bells and joints so that the pipe will be uniformly supported for its entire length.

3.5 BACKFILLING

Backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

3.5.1 Backfill Material Placement Over Pipes

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes to avoid damage to coatings or wrappings.

3.5.2 Trench Backfilling

a. Backfill as rapidly as construction, testing and acceptance of work permits.

b. Initial backfill shall be sand as specified. Place sand in 6" lifts to 12" above top of pipe. Compaction shall be 95% of the modified proctor.

c. Backfill material shall be as specified in (Products) paragraph "Backfill and Fill Material". Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

3.6 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved borrow materials shall be obtained as specified herein.

3.7 BURIED WARNING AND IDENTIFICATION TAPE

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.8 BURIED DETECTION WIRE

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken, from valve to valve. The ends of the wire shall terminate inside the valve boxes, with a minimum of 3 feet of wire, coiled, remaining accessible in each valve box. The wire shall remain insulated over it's entire length.

3.9 PIPELINE CASING UNDER PAVEMENT

Provide new smooth wall steel pipeline casing under pavement and at other indicated locations by the boring and jacking method of installation. Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated.

3.9.1 Earthwork for Pipeline Casings

Provide excavation, sheet piling, shoring, dewatering, and backfilling for pipeline casings under this section.

3.9.2 Steel Cased Pipelines

Install pipeline casing by dry boring and jacking method as follows:

3.9.2.1 Hole for Pipeline Casing

Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1/D1.1M. Do not use water or other fluids in connection with the boring operation.

3.9.2.2 Cleaning

Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.

3.9.2.3 Piped Utilities

Support pipe in casing using polypropylene spacers as indicated.

3.9.2.4 End Seals

After installation of utility pipe in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and utility pipe.

3.10 FINISH OPERATIONS

3.10.1 Grading

Finish grades as indicated within one-tenth of one foot. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.10.2 Topsoil and Seed

Scarify existing subgrade. Provide 4 inches of topsoil for newly graded finish earth surfaces and areas disturbed by the Contractor. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading. Additional topsoil will not be required if work is performed in compliance with stripping and stockpiling requirements. If there is insufficient on-site topsoil meeting specified requirements for topsoil, provide topsoil required in excess of that available. Provide seeding as specified in Section 02921 Seeding.

3.10.3 Protection of Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.11 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property surplus or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber.

3.12 FIELD QUALITY CONTROL

3.12.1 Sampling

Take the number and size of samples required to perform the following tests.

3.12.2 Testing

Perform one of each of the following tests for each material used. Provide additional tests for each source change.

3.12.2.1 Bedding and Initial Backfill Material Testing

Test bedding and initial backfill material in accordance with ASTM C 144 for conformance to ASTM C 144 gradation limits.

3.12.2.2 Backfill Material Testing

Test fill and backfill material in accordance with ASTM C 136 for conformance to ASTM D 2487 gradation limits; ASTM D 1140 for material finer than the No. 200 sieve; ASTM D 4318 for liquid limit and for plastic limit; ASTM D 1557 for moisture density relations.

3.12.2.3 Density Tests

Test density in accordance with ASTM D 1556, or ASTM D 2922 and ASTM D 3017. When ASTM D 2922 and ASTM D 3017 density tests are used, verify density test results by performing an ASTM D 1556 density test at a location already ASTM D 2922 and ASTM D 3017 tested as specified herein. Perform an ASTM D 1556 density test at the start of the job, and for every 10 ASTM D 2922 and ASTM D 3017 density tests thereafter.

a. Bedding, initial backfill and final backfill in trenches: One test per 200 linear feet in each lift.

3.12.2.4 Moisture Content Tests

In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D 2216. Include moisture content test results in daily report.

-- End of Section --

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Division 01 GENERAL REQUIREMENTS: Drawings, quality, product and performance requirements, general and supplemental conditions apply as applicable to the project and project requirements.

1.2 SUMMARY

A. This section includes materials applicable for commercial, industrial and security decorative metal perimeter enclosure systems. Extent of decorative metal fencing and gates as indicated on drawings.

1. Roll formed metal vertical ultra high strength pickets.
2. Steel Framework comprised of welded and roll-formed metal components.
3. All necessary metal gates, as required, comprising of the same materials as the pickets (infill) and metal framework.
4. All necessary metal fittings and fasteners.

1.3 REFERENCES

A. ASTM D4214 -Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
B. ASTM A653/A653A -Standard Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
C. ASTM B117 -Practice for Operating Salt-Spray (Fog) Apparatus
D. ASTM D523 -Test Method for Specular Gloss
E. ASTM D2244 -Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates
F. ASTM A90 -Test Method for weight (mass) of coating on Iron and steel Articles with Zinc or Zinc Alloy Coatings
G. ASTM D2794 -Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation
H. ASTM D3359 -Test Method for measuring Adhesion by Tape Test
I. ASTM D522 -Test Method for flexibility
J. ASTM B-6 -Specification for Zinc Quality for Hot Dip Galvanized Protective Coatings of Carbon Steel
K. ASTM F1083-Specification for Pipe, Steel, Hot Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
L. ASTM F1043 -Specification for Strength and Protective Coatings for Metal Industrial Fence Framework
M. ASTM F2408 -Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets
N. ASTM D822 -Test Method for Accelerated Weathering Resistance
O. ASTM C94 -Specification for Performance of Cured Concrete Mix to have a minimum Compressive Strength of 3,000 psi at 28 days
P. ASTM D1654 -Testing Method for Evaluating Painted or Coated Specimen Subject to Corrosive Environments
Q. ASTM 714 -Test Method for Evaluation of Degree of Blistering of Paints
R. ASTM D3363 -Test Method for Film Hardness by Pencil Test
S. ASTM D968 -Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

T. ASTM D4214 -Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
U. ASTM D4587 -Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
V. ASTM D1308 -Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
W. ASTM D4145 -Test Method for Coating Flexibility of Pre-painted Sheet

1.4 SUBMITTALS

A. Shop Drawing: Site plan showing the layout of the fence location with dimensions, location of gate and opening size, cleared area, elevation of fences and gates, details of attachments and footings as required. Note: footing requirements may vary due to soil conditions, frost line and other local conditions. Consult with jurisdictional authority regarding requirements of local conditions.

B. Wind load calculations for fencing rails, pickets, posts, & gates using 90 mph for 3 second gust.

C. Certifications: Manufacturers material certification shall be in compliance with current ASTM or other applicable specifications.

D. Domestic certifications: Made in U.S.A, Buy American Act or otherwise as required.

E. LEED certification: Not required for this project.

F. There shall be NO material changes proposed to alter the specified system after the acceptance of bids.

G. The manufacturers' literature, steel mill certifications, paint documentation, field touch-up paint documentation, and shop drawings shall be submitted and approved by Government prior to material shipment or installation.

H. Specifying agent shall choose color choice from manufactures' stock colors:

1. Patrician Bronze
~~2. Canyon Brown~~

1.5.1 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company must have five years of experience specializing in the fabrication, assembly and design of specialty fluoropolymer-coated decorative metal fences, gates and enclosures as utilized by the US Department of Defense.

B. Contractor Qualifications: Installer shall have demonstrated successful experience installing similar projects and have a thorough understanding of local conditions, jurisdictional requirements and the necessity to identify under grade hazards and utility services.

1.6 DELIVERY, STORAGE AND HANDLING

A. Upon delivery to either the job site or any other location designated by contractor, verification by recipient shall confirm that all materials were delivered in good condition and that items cosigned are all accounted for.

B. Materials shall be securely stored in a manner to provide proper ventilation, drainage and protection from the elements of weather.

C. Product shall be handled in a manner to preserve the integrity of the high performance coating.

PART 2 – MATERIALS

2.1 MANUFACTURER

A. Shall be manufactured by the following, or equal:

BaSteel Perimeter Systems, Inc.
1400 Magnolia Ave
Frankfort, IN 46041
(866)-369-8335
www.basteel.com

Rhon, Inc.
802 North First Street
Monticello, IN 47960
(574) 297-5217
www.rhonfence.com

2.2 MATERIAL

A. All fencing components shall have protective galvanized G-90 under coat applied prior to the top coat protection. Then a two-coat, thermo cured paint system consisting of a primer bottom coat and a fluoropolymer top coat shall be applied. Fluoropolymer top coat shall contain not less than 70 percent **polyvinylidene fluoride** (Kynar 500®/ Hylar 5000®) resin by weight meeting minimum performance requirements of 10 years outdoor exposure of South Florida 45° with less than 5 units color change as per ASTM D2244 and a chalk rating of no less than 8 as per ASTM D4214. Primer bottom coat shall be as specified by top coat manufacturer.

B. Infill pickets 5" minimum in width shall be roll formed from either minimum 0.017" (25 gauge) full hard 80,000 psi or minimum 0.030" (22 gauge) 50,000 psi yield strength steel in accordance with ASTM A653.

1. Vertical picket/ infill orientation

a. Shadow-box (pickets on both faces of rail, 3-7/8" gap, 21 pickets per section)

~~b. Semi-private (pickets on outer face of rail only, 2-3/8" gap, 13 pickets per section)~~

C. Rails, channels and brackets shall be 0.073" (14 gauge) ASTM A653 high strength 50,000 minimum psi yield steel. A protective galvanized G-90 under coat is applied prior to the thermo cured top coat protection. Hand file sharp edges & touch-up field cut rails with same color & finish as specified in 2.2, A.

1. "C" roll formed channel rails 1 ¼" x 1 ½"

a. Flat square back brackets (to be used with square posts)

~~b. Round back brackets (to be used with round posts)~~

c. Column brackets (to be used on masonry pillars or walls)

D. Posts shall have a top coat protection as specified in 2.2, A. Contractor shall tool bottom of post at entry to concrete creating a 3/8 inch depth x 1/4 inch width cavity. After concrete has cured 7 days, apply matching sealant to cleaned cavity creating positive drainage away from post. Refer to gate frames for additional notes on the hinging post.

1. Square:

a. 4.0"x 4.0" x 0.120" wall (11 gauge) high strength 50,000 psi minimum yield in accordance with ASTM A500 and shall be zinc coated in accordance with ASTM F1043 type B.

b. 6.0"x 6.0" x 0.250" wall in accordance with ASTM A500 and shall be hot dipped galvanized with a minimum 1.8 ounce per square foot.

~~2. Round:~~

~~a. 4.0" O.D. x 0.160" (8 gauge) wall manufactured in accordance with ASTM F1043 group 1-C and shall be zinc coated in accordance with ASTM F1043 type B.~~

~~b. 6-5/8" x 0.280" wall (schedule 40) manufactured in accordance with ASTM F1083.~~

E. All gate frames shall meet the same material and performance specifications as sited for rails and posts in Section 2.2. All gate infill or pickets shall conform to the standards specified for pickets and infill material sited in Section 2.2. Welding of gate frames and other components, as necessary and recommended by the manufacturer, shall be with silicon bronze welding wire, conforming to AWS A5.7 ERCuSi-A and/or ASME SFA5.7 requirements, as to inhibit corrosion. Remove all sharp edges from cuts, bends and welding splatter PRIOR to factory finish being applied. Perimeter gate frame shall have miter cut corners, welded and ground smooth prior to coating. All picket or infill materials shall be in-cased on all four sides by perimeter gate frame. Hinges shall be welded to gate frame vertical and clamped around hinging post allowing for field adjustability. Pivot points shall be double sealed bearings. Industrial cane rod shall be supplied on each gate leaf. Provide concrete surrounded receiver in ground plane for rod in the closed & fully open positions.

1. Single Swing Gate (openings less than 8')

   a. Gate frame shall be comprised of 2.0"x 4.0" x 0.073" wall (14 gauge) minimum and reinforced with 1.0"x 2.0" x 0.060" wall (16 gauge) minimum diagonal corner braces. All construction shall be high strength 50,000 psi minimum yield in accordance with ASTM A500 and zinc coated in accordance with ASTM F1043 type B. Provide lockable gate latch to allow access from both sides. Industry standard fork latch will NOT be accepted.

2. Single Swing Gate (opening greater than 8')

   a. Gate frame shall be comprised 2.0"x 4.0" x 0.073" wall (14 gauge) minimum and reinforced with 1.0"x 2.0" x 0.060" wall (16 gauge) minimum diagonal corner braces. All construction shall be high strength 50,000 psi minimum yield in accordance with ASTM A500 and zinc coated in accordance with ASTM F1043 type B. Hinges shall be welded to gate frame vertical 2.0"x 4.0" x 0.165" wall (8 gauge) minimum high strength 50,000 psi minimum yield in accordance with ASTM A500 and shall be zinc coated in accordance with ASTM F1043 type B and clamped around hinging post. Provide lockable gate latch to allow access from both sides. Industry standard fork latch will NOT be accepted. Posts shall be 6" as described above in Section 2.2 D.

3. Double Swing Gate (openings less than 16')

   a. Gate frame shall be comprised of 2.0"x 4.0" x 0.073" wall (14 gauge) minimum and reinforced with 1.0"x 2.0" x 0.060" wall (16 gauge) minimum diagonal corner braces. All construction shall be high strength 50,000 psi minimum yield in accordance with ASTM A500 and zinc coated in accordance with ASTM F1043 type B. Industrial cane rod shall be lockable for each leaf.

4. Double Swing Gate (openings 16’ and greater)

a. Gate frame shall be comprised 2.0”x 4.0” x 0.073” wall (14 gauge) minimum and reinforced with 1.0”x 2.0” x 0.060” wall (16 gauge) minimum diagonal corner braces. All construction shall be high strength 50,000 psi minimum yield in accordance with ASTM A500 and zinc coated in accordance with ASTM F1043 type B. Hinges shall be welded to gate frame vertical 2.0”x 4.0” x 0.165” wall (8 gauge) minimum high strength 50,000 psi minimum yield in accordance with ASTM A500 and shall be zinc coated in accordance with ASTM F1043 type B and clamped around hinging post. Industrial cane rod shall be lockable for each leaf. Posts shall be 6” as described above in Section 2.2 D.

F. Infill fasteners shall be color coated to match infill color. Infill fasteners shall have a minimum pull out tensile strength of 5,500N. Carriage bolts, nuts and bracket screws shall be stainless steel. All other miscellaneous hardware shall be corrosion resistant (galvanized).

G. Provide manufacturer and manufacturing date on stamped galvanized sheet metal (1”x2”) attached with stainless steel rivets to the interior face of horizontal rail near gate location.

H. All gates frames and fence posts shall be full length piping. No splices unless approved by Contracting Officer.

3.0 FABRICATION AND INSTALLATION

A. Pickets, rails, posts and accessories shall be provided as detailed in shop drawings or as otherwise suggested by the manufacturer.

B. Do not place footings against subgrade containing free water, frost, or ice.

C. The installed system shall be in accordance with the manufacturer’s instructions. The finished fence system shall surpass the vertical and horizontal loads, and infill performance of industrial weight fences under ASTM F2408.

D. The jobsite shall be cleaned of excess materials; post-hole excavations shall be removed.

E. Contractor shall identify and mark the location of underground utility service or other below grade hazards prior to installation.

F. Contractor shall seek the consultation and approval from the manufacturer for footings based on local requirements and other factors such as frost line and soil conditions.

G. Gates must be designed per application considering location, elements, security and frequency of cycles. Gate posts shall be per manufacturer’s recommendation and in accordance with applicable codes, standards and acceptable jurisdictional practices.

H. Any touch-up paint used shall be of same color & finish as specified in 2.2, A.

I. Adjusting

1. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

J. Provide Best 21B722LWC (Best 21B series, 7 pin housing, stainless steel, 1-1/2" shackle, with weather cover) for all equipment yard gates.

*** End of Section ***

SECTION 33 30 00

SANITARY SEWERS
04/08

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Sanitary Sewer Gravity Pipeline

Provide building connections of polyvinyl chloride (PVC) plastic pipe. Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C111/A21.11	(2012) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C600	(2010) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2013) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA M23	(2002; 2nd Ed) Manual: PVC Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM D2321	(2014; E 2014) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	(2011) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D2680	(2001; R 2014) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D3034	(20115) Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F949	(2015) Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.3.1 SD-03 Product Data

Pipeline Materials

1.3.2 SD-06 Test Reports

Reports

1.3.3 SD-07 Certificates

Request for Pre-Connection Inspection; G

Post-Construction Inspection; G

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

1.5.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Carry, do not drag, pipe to trench.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below. Submit manufacturer's standard drawings or catalog cuts.

2.1.9 PVC Plastic Gravity Sewer Piping

2.1.9.1 PVC Plastic Gravity Pipe and Fittings

ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.

2.1.9.2 PVC Plastic Gravity Joints and Jointing Material

Joints shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.

2.4 REPORTS

Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear feet.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

Submit request for field support from the Installation's Utilities Field Support two weeks prior to making connection. Submit request for pre-connection inspection to be conducted after trenching and layout is completed, but before the proposed service has been connected.

3.1.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.1.2.1 Location

The work covered by this section shall terminate at a point approximately 5 feet from the building, unless otherwise indicated. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 10 feet to a water main or service line. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 10 feet on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 3 feet, horizontal distance, to the water line.

3.1.2.1.1 Sanitary Piping Installation Parallel with Water Line

3.1.2.1.1.1 Normal Conditions

Sanitary piping or manholes shall be laid at least 10 feet horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.

3.1.2.1.1.2 Unusual Conditions

When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:

a. The top (crown) of the sanitary piping shall be at least 18 inches below the bottom (invert) of the water main.

b. Where this vertical separation cannot be obtained, the sanitary piping shall be constructed of AWWA-approved ductile iron water pipe pressure tested in place without leakage prior to backfilling.

3.1.2.1.2 Installation of Sanitary Piping Crossing a Water Line

3.1.2.1.2.1 Normal Conditions

Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.

3.1.2.1.2.2 Unusual Conditions

When local conditions prevent a vertical separation described above, use the following construction:

a. Sanitary piping passing over or under water lines shall be constructed of AWWA-approved ductile iron water pipe, pressure tested in place without leakage prior to backfilling.

b. Sanitary piping passing over water lines shall, in addition, be protected by providing:

(1) A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.

(2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.

(3) That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the water line.

3.1.2.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell ends in the upgrade direction. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam

method may be used in lieu of batterboards for the same purpose. Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for PVC composite pipe shall conform to Figure 2 of ASTM D2680; and saddles for PVC pipe shall conform to Table 4 of ASTM D3034.

3.1.3.9 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.3.10 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section; with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

3.1.3.10.2 Pipe 4 Inch Diameter Joints

Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to fittings, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel.

3.1.8 Installations of Wye Branches

Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Post-Construction Inspection

Submit post-construction inspection request for field support from the Installation's Utilities Field Support two weeks prior to post-connection inspection.

Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Dye must be a nontoxic non-staining sewer tracing dye. Test results are to be noted in the daily Construction Quality Control (CQC) Report.

a. Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.

3.2.3.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.2.3.1.2 Low-Pressure Air Tests

Perform tests as follows:

3.2.3.1.2.5 PVC Plastic Pipelines

Test in accordance with UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.2.3.2 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

3.2.3.2.1 Pull-Through Device

This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of

a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

b. Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface Brinell hardness of not less than 150.

c. Center bored and through-bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.

d. Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

3.2.3.2.2 Deflection Measuring Device

Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.

3.2.3.2.3 Pull-Through Device Procedure

Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

3.2.3.2.4 Deflection measuring device procedure

Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

-- End of Section --

SECTION 34 71 13.16

VEHICLE CRASH BARRIERS
02/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 180	(2012) Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail
AASHTO M 30	(2002; R 2010) Standard Specification for Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail
AASHTO MASH	(2009; Rev 1) Manual for Assess Safety Hardware

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2010) Standard Specification for Carbon Steel Tee Rails
ASTM A1035/A1035M	(2016a) Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A242/A242M	(2013) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A27/A27M	(2013; R 2016) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A307	(2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A449	(2014) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
ASTM A499	(2015) Standard Specification for Steel Bars and Shapes, Carbon Rolled from "T" Rails
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A568/A568M	(2014) Standard Specifications for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A588/A588M	(2015) Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A709/A709M	(2016a) Standard Specification for Structural Steel for Bridges
ASTM B695	(2004; R 2009) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C94/C94M	(2016a) Standard Specification for Ready-Mixed Concrete
ASTM D4956	(2013) Standard Specification for Retroreflective Sheeting for Traffic Control

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

NCHRP 350 (1993) Recommended Procedures for the Safety Performance Evaluation of Highway Features

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

FHWA Acceptance Letter

SD-08 Manufacturer's Instructions

End Anchorage

Submit at least 14 days prior to installation.

Crash Cushion

Submit at least 14 days prior to installation.

PART 2 PRODUCTS

2.1 GUARDRAIL POSTS

Guardrail posts ARE steel and of the dimensions indicated here and in drawing sheet A305 . Unless otherwise indicated, use only one type of post throughout the project.

2.1.2 Steel Posts

Fabricat "H" beam sections from steel conforming to either ASTM A36/A36M, ASTM A588/A588M or ASTM A242/A242M and conforming to the size, weight and dimensions indicated. Use bolts must be of the diameters indicated. Bolts used with galvanized ASTM A36/A36M steel must conform to ASTM A307. ASTM A325M(ASTM A325), Type 3 bolts may be used with ASTM A588/A588M or ASTM A242/A242M steel without galvanizing. Galvanize bolts, posts, and all necessary hardware fabricated from ASTM A36/A36M steel in accordance with ASTM A123/A123M.

2.2 W-BEAM GUARDRAIL

Provide galvanized steel beam guard rail elements and fittings of the indicated design and details. The finished steel beam elements must be Class A (base metal nominal thickness 2.67 mm (0.105 inch) and conform to the requirements of AASHTO M 180. Galvanizing of steel beam elements shall be Type 1 (zinc coated 550 grams per square meter (1.80 ounces per square

foot), minimum single spot) and must conform to the requirements of AASHTO M 180.

2.3 "W' BEAM END SECTION

Provide "W" beam end sections of the same or greater thickness of metal and the same type as the beam to which it is attached.

2.4 GUARDRAIL HARDWARE

All fittings (bolts, nuts, washers, etc.) for guardrail must conform to the requirements of AASHTO M 180.

Bolt Use	Bolt Size and Configuration	
Rival Splices	16 mm 5/8 inch diameter	Button head type with oval shoulder conforming to alternative No. 1 or 2 configuration of AASHTO M 180
Fastening Rail to Steel or Timber Blocks	16 mm 5/8 inch diameter	Button head type with oval shoulder conforming to alternative No. 1 or 2 configuration of AASHTO M 180
Rail Splices	35 mm 1.25 inches long	
Fastening Rail to Steel Block	50 mm 2 inches long	Minimum thread length of 45 mm 1.5 inches
Fastening Rail to Timber Block and Post	460 mm 18 inches long	Minimum thread length of 100 mm 2.5 inches
Fastening Steel Block to Post	50 mm 1.5 inches long	16 mm 5/8 inch diameter hex head type

2.5 TERMINAL FOR W-BEAM GUARDRAIL

Terminal for w-beam guardrail must be a flared OR Slotted Rail Terminal (SRT-350).

2.6.5 Steel Posts
2.6.5.1 Structural Steel Posts

Provide structural steel posts and anchor plates conforming to ASTM A36/A36M. Galvanize in accordance with ASTM A123/A123M.

2.6.7 Concrete

ASTM C94/C94M, using 19 mm (3/4 inch) maximum aggregate, and having minimum compressive strength of 28 MPa (4000 psi) at 28 days. Reinforcing steel must be deformed bars conforming to ASTM A615/A615M, ASTM A706/A706M, or ASTM A1035/A1035M grade 280 (40).

PART 3 EXECUTION

3.1 POSTS

Posts placed by setting in excavated holes. Post holes for guardrail posts must be round and at least 100 mm (4 inches) larger, in diameter, than the greater dimensions (not the diagonal) of the posts, and SET IN CONCRETE

3.2 GUARDRAIL BEAM ELEMENTS

Place and fasten the beam elements, fittings, and other parts of the guardrail as indicated. Erect the elements to produce a smooth, even rail, closely conforming to a line and grade parallel to the pavement. Bolt the beam elements to each post, and make splices by lapping in the direction of traffic. Splice only at posts. Tighten all bolts in the finished rail.

-- End of Section --

ENVIRONMENTAL REMEDIATION SPECIFICATION

Prepared for:

Dyess Air Force Base

Repair Maintenance Shop

Building 8040

Prepared by:

Facility Performance Associates

May 2016

TABLE OF CONTENTS

1.0 GENERAL INFORMATION

1.1 Executive Summary

Dyess Air Force Base Building 8040 has an approximate square footage of 11,028 SF. The scope of this project will be to renovate and construct an addition to building 8040. The addition includes square footage for offices, toilets and showers. The renovation includes HVAC systems, lighting, electrical, fire protection, plumbing, roofing, doors, windows and parking. Features to remain include the building's metal frame, bracing, concrete floor, paint booth and accessories, and existing exterior air compressors.

This intended use of this plan is to successfully remediate Building 8040 at Dyess Air Force Base while protecting worker health and promoting future occupant health. Objectives include abatement of lead, cadmium and chromium dust in the interior and exterior enclosure systems, and in soil underneath and surrounding the building.

1.2 Site Background

1.2.1 Site Location and Current Use

The existing engineered metal building was constructed in 1963 and has experienced numerous renovations since that time.

1.2.2 Proposed Redevelopment Plan

Renovations will be in accordance with AFMAN 32-1084 standards and will include HVAC, lighting, electrical, fire protection, plumbing, roofing, doors, windows and parking to meet applicable standards and codes including life safety codes, ABA and AT/FP standards.

Renovations to the existing building include the design and addition to accommodate the personnel requirements as follows: 1 NCO office, 1 assistant office, 8 hot desks, 1 break room, 2 male showers, 2 female showers, 1 dirty locker room, 1 clean locker room, 1 janitor closet. Include accessory spaces such as air shower(s), respirator cleaning station(s) per UFC 4-211-02.

1.2.3 Existing Conditions to Remain in Place

The metal building frame, bracing and concrete floor shall remain. The existing paint booth and accessories shall remain. The existing exterior air compressors shall remain. Any item indicated as existing to remain shall be protected from damage throughout construction.

1.3 Regulations

The contractor will be responsible for adhering to all federal, state and local laws and regulations which include, but is not limited to, the following:

1. American National Standards Institute (ANSI)
    a. ANSI A10.6 (1990; R 1998) Safety Requirements for Demolitions Operations

2. U.S. Department of Labor, Occupational Safety & Health Administration (OSHA)
    a. 29 CFR Section 1926, Subpart T: Demolition

3. Texas Administrative Code (TAC)
    a. 30 TAC Part 1: Texas Commission on Environmental Quality (TCEQ)

1.4 Site Safety & Supervision

The Contractor shall follow base standard safety and Occupational Safety and Health Administration (OSHA) guidelines throughout construction duration.

The Contractor shall assign a Competent Person (as defined by OSHA regulations 29 CPR Sec. 1926.32(f)) to be on the site at all times during work activities who is capable of identifying existing and predictable hazards in the surroundings or working conditions and is responsible for the overall safety of the site.

1.5 Permits & Fees

The Contractor shall secure and pay for all permits, governmental fees including removal fees, licenses and inspections necessary for proper execution of remedial action in accordance with all laws, ordinances, rules and regulations.

1.6 Sampling & Testing

The contractor shall identify a third party to conduct any sampling or testing of materials. If the third party identified is not employed by the Air Force, the Contractor shall submit information about the third party including scope of work and procedures used to compete scope of work for Air Force approval.

2.0 REMEDIAL INVESTIGATION

2.1 Investigation Findings

On August 6, 2014, SrA Disque and A1C Smith of Bioenvironmental Engineering (BE) performed bulk sampling at Building 8040 to confirm the presence of chromium (IV), cadmium and lead inside the building. Table 1 below summarizes the results:

Table 1: Bioenvironmental Engineering Contamination Report Results

Sample # (Sample Report Date)	Contaminant	Reporting Limit (mg/kg)	Result (mg/kg)
0000C0N7 (15 August 2014)	Cadmium	10.2	40.4
0000C0NB (26 August 2014)	Chromium (VI)	5.77	18,900
0000C0N7 (15 August 2014)	Lead	51.2	749

All air samples that were taken by Bio in the past were conducted inside the paint/blast booths and were used to determine the exposure limits of the users. There is one wipe sample for the building, showing the presence of contamination.

All surfaces above and including the floor shall be assumed to hold dust containing hexavalent chromium (chromium (VI)), cadmium, strontium, and lead. This shall include surfaces above the Offices, Toilets, Showers, Janitor, Paint Booth, Blast Booth, exposed ductwork, conduit, heater units, light fixtures, piping, structural members, insulation, etc.

The contractors should be aware of "Respirable Particles" containing strontium chromate, cadmium, and lead. Strontium chromate (chromium (VI)) and cadmium are the ingredients that exceeded OSHA inhalation action levels. Lead never exceeded any inhalation standards but sampling indicated presence. Personnel entering Building 8040 should avoid activities that re-suspend dust into the air.

Elevated levels of hexavalent chromium, cadmium, strontium, and lead were detected in paint dust/residue inside Building 8040. If materials are not removed, worker protection (PPE) shall be required during demolition/renovation for activities conducted inside the existing building.

The full investigative report can be found in Appendix B.

3.0 REMEDIAL OBJECTIVES

Based on the results of the Remedial Investigation, the following Remedial Action Objectives have been identified for this site.

3.1 Interior & Exterior Enclosure Systems

Interior and exterior enclosure systems shall not contain levels of cadmium, chromium (VI) and lead exceeding the permissible exposure limit defined by OSHA as the maximum level of airborne particle concentration at which an individual may be exposed over an 8-hour time period:

Table 2: Permissible Exposure Limit Defined by OSHA

Contaminant	PEL ($\mu g/m^3$)
Cadmium (as dust)	5
Chromium (VI)	5
Lead	50

3.2 Soil

Tests to determine soil conditions have not been conducted. Similar dust levels to the inside are assumed to have contaminated adjacent soil.

Remedial actions include the reduction of metal leaching through soil and bio-availability to human and ecological receptors. Soil shall not contain levels of cadmium, chromium (VI) or lead exceeding the maximum concentration of contaminants for the toxicity characteristic.

Table 3: Maximum Concentration of Contaminants for the Toxicity Characteristic

Contaminant	EPA Hazardous Waste No.	Regulatory Level (mg/L)
Cadmium	D006	1.0
Chromium (VI)	D007	5.0
Lead	D008	5.0

4.0 REMEDIAL ACTION PLAN

Based on the generation of the Remedial Investigation and the Remedial Objectives, the following Remedial Action Plan has been developed for this site.

Based on the generation of the Remedial Investigation and the Remedial Objectives, a Remedial Action Plan has been developed for this site. The general sequence of remedial action shall occur in the following order:

1. After initial wet mopping and vacuuming of all surfaces of the paint booth is completed disconnect electrical systems and power wash all paint booth metal and

hard surfaces on all sides. Collect wastewater and remove to appropriate disposal site. Test for contaminants. If tests verify acceptable conditions, relocate paint booth to a protected location until reinstalled. Re-clean prior to occupancy if necessary.

2. Perform similar dust removal and cleaning operation on air compressors and other equipment to be reused. Test for contaminants. If tests verify acceptable conditions, relocate to a protected location until reinstalled. Re-clean prior to occupancy if necessary.

3. Remove insulation, ceiling tile, gypboard and all other 'soft' materials. Test for contamination and wrap in 6-mil poly if hazardous. Remove to appropriate disposal site.

4. Disconnect electrical power sources and power wash the remaining interior building materials and fixtures. Collect wastewater and remove to appropriate disposal site.

5. Power wash both sides of exterior walls and roof. Collect wastewater and remove to appropriate disposal site. Repeat if necessary. Remove exterior wall and roof materials. Test for contamination and wrap in 6-mil poly if hazardous. Remove to appropriate disposal site.

6. Power wash the remaining building structural elements and slabs. Collect wastewater and remove to appropriate disposal site. Repeat if necessary.

7. Test soil for contamination. If contaminants are detected, remove, remediate and dispose of soil to 5 feet beyond and below contaminated soil. Replace with clean select fill materials.

4.1 Interior & Exterior Enclosure Systems Abatement

Worker protection is required during demolition and renovation activities to prevent exposure to contaminated dusts. Workers shall wear a disposable protective suit, respirator, work gloves and boots/booties. Workers shall also wear eye protection at all times.

Prior to any major demolition activities, as much dust as possible shall be removed from the interior and exterior systems of Building 8040. The following dust removal procedures shall be followed for interior systems:

4.1.1 General Procedures

1. Remove any large contaminated debris, wrap in 6-mil poly and seal/secure with duct tape. Label "contaminated" and store in a secured area until it can be tested and disposed of properly.

2. HEPA vacuum all surfaces. Begin with ceilings and work down. Use the corner tool to clean where the wall meets the ceiling and floor. Wrap used HEPA vacuum filters in 6-mil poly and seal/secure with duct tape. Label "contaminated" and store in a secured area until it can be tested and disposed of properly.

3. Wet mop the floor of the building to prohibit dusts from re-suspending into the air. Collect any small debris, including mop heads, wrap in 6-mil poly and seal/secure with duct tape. Label "contaminated" and store in a secured area until it can be tested and disposed of properly.

4. HEPA vacuum and wet mop once more to ensure dust removal.

Dust removal and containment shall continue throughout the demolition and renovation process. Any power washing activities shall be done in accordance with section 4.4.3 as well as any other applicable rules and regulations.

4.2 Soil Remediation

Soil samples shall be taken from multiple locations surrounding the building and tested for contaminants of concern. Soil exceeding the maximum concentration of contaminants for the toxicity characteristic, Table 3, will be treated as hazardous and must be properly stored on site and disposed of.

Soil not exceeding the regulatory levels requires no remedial action and may be disposed of as normal waste.

If remedial action is required the project team may pursue one of the following options:

4.2.1 Option 1: Soil Excavation

The proposed remedial action will consist of:

1. Establish Soil Cleanup Objectives (SCOs). Excavation and removal of soil/fill shall meet or exceed SCOs.

2. Prior to excavation activities a site mobilization plan shall be implemented involving site security setup, equipment mobilization, utility mark outs and marking and clearly identifying excavation areas.

3. Storm Water Pollution Prevention Plan shall be implemented in accordance to local laws and regulations.

4. Performance of all activities required for remedial action including permitting and pretreatment requirements shall be done in accordance to local laws and regulations.

5. Testing of excavated soil/fill as required by disposal facilities shall be done prior to transportation.

6. Transportation and off-site disposal of all soil/fill material at permitted facilities in accordance with applicable laws and regulations for handling, transport and disposal.

7. Collection and analysis of end-point soil samples to determine the effectiveness of the remedial action with reference to the SCOs.

8. Submission of a Remedial Action Report describing remedial activities and confirming that the activities have met the Soil Cleanup Objectives.

9. Construction and maintenance of an engineered composite cover of a six inch minimum concrete building slab to prevent human exposure to residual soil/fill remaining under the site if SCO objectives are not achieved.

10. If Soil Cleanup Objectives are not met, a Site Management Plan shall be developed for the long term management of residual contamination. The Site Management Plan shall include plans for operation, maintenance, monitoring, inspection and reporting at a specified frequency.

4.2.2 Option 2: Paving

The proposed remedial action will consist of:

1. Construction and maintenance of an engineered composite cover of a six inch minimum concrete building slab to prevent human exposure to contaminated soil/fill remaining under the site.

4.3 Waste Disposal

All personnel shall comply with U.S. EPA, state and local regulations for waste disposal as well as all applicable RCRA regulations.

4.3.1 Waste Classification

40 CFR Part 261 defines hazardous solid waste. If the Toxicity Characteristic Leaching Procedure (TCLP) extract contains any one of the toxicity characteristic constituents in an amount equal to or exceeding the concentrations specified in the table below, the waste possesses the characteristic of toxicity and is a hazardous waste.

TCLP is a sampling method used to determine if a waste will leach chemicals into the soil or groundwater. Table 4, below, describes the EPA regulatory limits by the TCLP.

Table 4: Toxicity Characteristic Leaching Procedure (TCLP) Regulatory Levels

Contaminant	EPA Hazardous Waste No.	Limit (mg/L TCLP)
Cadmium	D006	1.0
Chromium (VI)	D007	5.0
Lead	D008	5.0

40 CFR part 268 identifies treatment standards required by Land Disposal Restrictions (LDR) to regulate prohibited waste. The following limits in Table 4, below, shall be tested by TCLP to simulate leaching through a landfill.

Table 5: TCLP Hazardous Waste Limits Required by Land Disposal Restrictions

Contaminant	EPA Hazardous Waste No.	Limit (mg/L TCLP)
Cadmium	D006	0.11
Chromium (VI)	D007	0.60
Lead	D008	0.75

The following materials shall be tested to determine whether or not they are hazardous and exceed waste limits required by Land Disposal Restrictions:

- Abatement materials such as paint chips, spent abrasives, etc.
- Containment materials such as plastic sheets, duct tape, or tape used to cover floors during abatement activities.
- Liquid waste (i.e. wash water).
- Sponges, mops, HEPA filters, respirator cartridges, and other materials used for testing, dust control and cleanup.
- Any other contaminated items such as demolition debris.

If any of the above exceed waste limits required by the Land Disposal Restrictions they will require proper on-site storage, transportation and disposal as specified by sections 4.3.2 and 4.3.3.

4.3.2 On-Site Storage of Solid Waste

Contaminated waste shall be stored on site in a designated and secured area until it is hauled off-site to a designated landfill.

4.3.3 Collection & On-Site Storage of Liquid Waste

Wastewater generated from power washing activities is considered industrial wastewater and must be properly managed.

Option 1: Discharge Wastewater through a Sanitary Sewer

If the site allows access to a Publicly Owned Treatment Works (POTW) facility through a sanitary sewer, the project may request authorization to discharge power washing wastewater through that sewer. It is important the POTW knows the characteristics of the wastewater and when the wastewater will be discharged into the sanitary sewer. A containment pad, berm and pump system can be used to contain wastewater and divert to the sanitary sewer. The wastewater may NOT be discharged directly into storm drains/sewers.

Option 2: Collect Wastewater and Arrange for Disposal at Off-Site Facility

If there is not access to a sanitary sewer, the wastewater must be collected on-site. There is not a specific type of containment that must be used, however, a containment pad, berms and pump system may be used to contain wastewater and divert to a holding tank. Disposal can be arranged through the local POTW or industrial waste disposal facility ahead of time in order to confirm the disposal site and ensure compliance with any other local rules and regulations. In some cases, the wastewater may require pretreatment to remove metals before the POTW can accept it.

4.3.4 Waste Transportation

Hazardous waste must be packaged in DOT approved containers, sealed, marked, and labeled per all applicable federal, state and local regulations, for transportation to the accepting disposal facility.

NOTE: Add waste hauler info here. Find landfill that will accept hazardous waste. Possibly enlist help from Mantis Environmental (or company offering similar services) for testing, transportation and disposal.

5.0 REMEDIAL MANAGEMENT

Remedial Management includes daily reports and photo documentation which shall be submitted to the Owner or Owner's representative on a weekly basis.

5.1 Daily Reports

The Contractor will be responsible for completing daily reports during the remedial action efforts. A sample daily report can be found in Appendix A.

5.2 Record Keeping & Photo Documentation

In addition to daily reports, the Contractor shall take photos demonstrating the remedial action progress on site. This includes demonstrating compliance with demolition standards, worker protection protocol, and any other applicable rules and regulations.

6.0 REMEDIAL ACTION REPORT

A Remedial Action Report shall be compiled upon project completion. It shall include a description of the success or failure of any remedial action and any final contamination testing results. A Site Management Plan shall be developed for the long term management of residual contamination. The Site Management Plan shall include plans for operation, maintenance, monitoring, inspection and reporting at a specified frequency. Add remedial action report upon completion to the Appendix (Appendix C: Remedial Action Report).

7.0 APPENDIX

See sheets inserted behind this page.

7.1 Appendix A

Appendix A contains sample daily report forms.

Dyess 8040 Daily Report Form	
Name/Title:	
Date:	
Persons Entering Site:	**Name** **Company** 1. _____ _____ 2. _____ _____ 3. _____ _____ 4. _____ _____
Describe any meetings or discussions regarding the project:	
Did any special or unusual events occur? If yes, explain:	
Additional Notes:	
Signature:	

7.2 Appendix B

Appendix B contains the initial investigative report by Bioenvironmental Engineering.

(report inserted behind this sheet)

DEPARTMENT OF THE AIR FORCE

7TH AEROSPACE MEDICINE SQUADRON (ACC)
697 LOUISIANA DRIVE, 1C9
DYESS AIR FORCE BASE, TEXAS 79607-1367

2 September 2014

MEMORANDUM FOR 7 EMS/MXMFS

FROM: 7 AMDS/SGPB

SUBJECT: Bulk Sampling Results, Structural Maintenance, Bldg 8040 WIC: 104A

1. On 6 August 2014, SrA Disque and A1C Smith of Bioenvironmental Engineering (BE) performed bulk sampling at Building 8040. The purpose of this sampling was to confirm the presence of chromium (VI), cadmium, and lead in the paint/primer that is sanded off AGE equipment due to previous coatings.

2. Sampling results are summarized in the table below; results are expressed in presence or absence.

Sample # (Sample Report Date)	Contaminant(s)	Result
0000C0NB (26 Aug '14)	**Chromium VI**	**Present**
0000C0N7 (15 Aug '14)	**Cadmium**	**Present**
0000C0N7 (15 Aug '14)	**Lead**	**Present**

3. BE has already evaluated airborne exposures of these hazards; those reports should be maintained at your workplace. At this time, the workplace supervisor is coordinating a facility-specific housekeeping and contamination avoidance plan with BE. The plan should be followed by all users of the facility to protect personnel from potential health effects of the hazards above, and to prevent spread of contamination to non-regulated work areas. Please maintain this report in your records. This memorandum requires no further action from the workplace.

4. If you have any questions regarding this evaluation please contact BE at 696-2325.

SMITH.LEAH.MARIE.1411826143 Digitally signed by SMITH.LEAH.MARIE.1411826143 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USAF, cn=SMITH.LEAH.MARIE.1411826143 Date: 2014.09.08 07:37:40 -05'00'

LEAH M. SMITH, A1C, USAF
Bioenvironmental Engineering Journeyman

Digitally signed by SOMERA.LEONARDO.G.III.1175891630 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USAF, cn=SOMERA.LEONARDO.G.III.1175891630 Date: 2014.09.03 14:18:42 -05'00'

LEONARDO SOMERA, Maj, USAF, BSC
Bioenvironmental Engineering Flight Commander

cc:
7 AMDS/SGPM

15 August 2014

MEMORANDUM FOR: 7 AMDS/SGPB Bioengineering
7 AMDS/SGPB
880 THIRD STREET, BLDG 8080
DYESS AFB, TX 79607-1397

FROM: USAFSAM OE Industrial Hygiene
2510 Fifth Street, Bldg 20840, Room W327
Wright Patterson Air Force Base, OH 45433-7913

SUBJECT: Order Number: W1408053

Enclosed is the sample report from 1 Sample received on 08/08/2014.

Samples, not consumed in analysis, will be held according to the appropriate regulatory authority unless you specifically request otherwise. Should you choose to reproduce this report, we recommend you do so in its entirety so that the integrity of the data package is kept intact.

If you have questions, or if we may be of further assistance to you, please do not hesitate to contact us.

Sincerely,

CRYSTAL C. BROWN, Capt, USAF
Analytical Services Program Manager
Tel: (937) 938-2523 (DSN Prefix: 798)
https://hpws.afrl.af.mil/dhp/OE/ESOHSC/pages/index.cfm?id=742

Note: Sample analysis performed by: USAFSAM/OE Chemistry Division - South Building WPAFB

USAFSAM OE Industrial Hygiene

Customer:	7 AMDS/SGPB
Project:	USAFSAM
Lab Work Order:	W1408053

CASE NARRATIVE

There were no problems associated with the samples or analysis except where noted below. Unless otherwise noted, sample results are not blank corrected, and all quality control associated with the samples were within acceptable limits. These results relate only to the items tested.

Method Reporting Limit recovery for Cadmium is above established limits. Results for Cadmium are considered estimate.

The Matrix Spike (MS) and Matrix Spike Duplicate (MSD) recovery and RPD for Lead are outside established limits, due to a suspected lack of sample homogeneity. Results for Lead are considered estimate.

Report of Analysis
for
7 AMDS/SGPB

WorkOrder: W1408053
Project: USAFSAM-01

Customer Sample ID:	0000C0N7	**Collection Date:**	08/06/2014
Lab Sample ID:	W1408053-01A	**Date Reported:**	08/15/2014
Matrix:	Bulk Solid	**Analyst:**	THOMAS SABIN
Site Identifier:		**Approver:**	BRUCE ROHRBACH
Sample Location:			
Prep:	EPA 3050B HOT BLOCK DIGESTION	**Prep Date:**	08/11/2014 10:00 AM

Analyte	Result	Reporting Limit	Qual	Units	DF	Date / Time / Analyzed
Method Reference:	EPA 6010C - TOTAL ICP METALS					
Cadmium	40.4	10.2		mg/Kg	1	08/14/2014 11:37:03 AM
Lead	749	51.2		mg/Kg	1	08/14/2014 11:37:03 AM

General Notes:

< Less than the indicated reporting limit.

-- Information not available or not applicable.

(a) Analysis indicates possible breakthrough

The calculated concentration (mg/m3) was obtained using the collection volume provided on the analysis request form.

Unless otherwise indicated, the sample results have not been blank corrected.

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Exceeds holding time

26 August 2014

MEMORANDUM FOR: 7 AMDS/SGPB Bioengineering
7 AMDS/SGPB
880 THIRD STREET, BLDG 8080
DYESS AFB, TX 79607-1397

FROM: USAFSAM OE Industrial Hygiene
2510 Fifth Street, Bldg 20840, Room W327
Wright Patterson Air Force Base, OH 45433-7913

SUBJECT: Order Number: W1408052

Enclosed is the sample report from 1 Sample received on 08/08/2014.

Samples, not consumed in analysis, will be held according to the appropriate regulatory authority unless you specifically request otherwise. Should you choose to reproduce this report, we recommend you do so in its entirety so that the integrity of the data package is kept intact.

If you have questions, or if we may be of further assistance to you, please do not hesitate to contact us.

Sincerely,

CRYSTAL C. BROWN, Capt, USAF
Analytical Services Program Manager
Tel: (937) 938-2523 (DSN Prefix: 798)
https://hpws.afrl.af.mil/dhp/OE/ESOHSC/pages/index.cfm?id=742

Note: Sample analysis performed by: USAFSAM/OE Chemistry Division - South Building WPAFB

USAFSAM OE Industrial Hygiene

Customer:	7 AMDS/SGPB
Project:	USAFSAM
Lab Work Order:	W1408052

CASE NARRATIVE

There were no problems associated with the samples or analysis except where noted below. Unless otherwise noted, sample results are not blank corrected, and all quality control associated with the samples were within acceptable limits.

These results relate only to the items tested.

Due to lab error, samples did not include QC during preparation. However, QC were prepped separately and included at end of run.

All bulk hexavalent chromium analyses are considered estimated due to the modification of Method N-7605 required for solid samples.

Report of Analysis
for
7 AMDS/SGPB

WorkOrder: W1408052
Project: USAFSAM-01

Customer Sample ID:	0000C0NB	**Collection Date:**	08/06/2014
Lab Sample ID:	W1408052-01A	**Date Reported:**	08/26/2014
Matrix:	Bulk Solid	**Analyst:**	JOSHUA BEVINS
Site Identifier:		**Approver:**	BRUCE ROHRBACH
Sample Location:			
Prep:	NIOSH 7605 BULK SAMPLE PREP	**Prep Date:**	08/19/2014 01:30 PM

Analyte	Result	Reporting Limit	Qual	Units	DF	Date / Time / Analyzed
Method Reference:	NIOSH 7605 Hexavalent Chromium					
Chromium, Hexavalent	18900	5.77	H	mg/Kg	10	08/14/2019 01:49:00 PM

General Notes:

< Less than the indicated reporting limit.

-- Information not available or not applicable.

(a) Analysis indicates possible breakthrough

The calculated concentration (mg/m3) was obtained using the collection volume provided on the analysis request form.

Unless otherwise indicated, the sample results have not been blank corrected.

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Exceeds holding time

20141205?

STAFF SUMMARY SHEET

	TO	ACTION	SIGNATURE (Surname), GRADE AND DATE		TO	ACTION	SIGNATURE (Surname), GRADE AND DATE
1	7 EMS/ CC	Approve	Kenneth H Fetters Maj, 16 Dec	6	7 MXG/ CD	Review/ ~~Sign~~ Coord	M Pollock LtCol 18 Dec 14
2	7 BW/ SED	Review/ Coord	Jack A..., GS-12 16 Dec	7	7 MXG/ CC	~~Coord~~ Review/ Sign	R. D..., O-6 24 Dec 14
3	7 MXG/ CSS	Coord	Bernard, E-4 17 Dec	8	7 MXG/ CSS	~~Coord~~ Route	14 Dec 14
4	7 MXG/ CCS	Review/ Coord	18 Dec 14	9	7 EMS/ CCS	Scan/ Coord	
5	7 MXG/ CCE	Review/ Coord	Renaldi O-1 18 DEC 14	10	7 EMS/ CCX	File	

SURNAME OF ACTION OFFICER AND GRADE	SYMBOL	PHONE	TYPIST'S INITIALS	SUSPENSE DATE
Maj Kenneth H. Fetters	7 EMS/CC	696-1790	jjr	

SUBJECT	DATE
Review and sign AF IMT 3	20141215

SUMMARY

1. SUMMARY: Risk Assesment Codes (RACs) required for:
Bldg 5112 due to excessive Hexavalent Chromium levels which exceed OSHA regulations
Bldg 8040 due to excessive Hexavalent Chromium levels which exceed OSHA regulations
Bldg 5004 due to inoperable interlock system which violates T.O. 33B-1-1 "THE INTERLOCK SYSTEM SHALL BE PLACED ON EACH DOOR TO INTERRUPT POWER TO THE CONTROL BOX/TUBE HEAD, STOPPING THE IRRADIATION PROCESS, WHEN UNAUTHORIZED ACCESS IS ATTEMPTED."
Bldg 8040 due to no transition area from regulated area to administrative area, causing unnecessary cross contamination of Cadmium, Hexavalent Chromium, Lead, and Methylene Chloride and violating UFC 4-211-2.
Bldg 8040 due to unnecessary exposure to Cadmium, Hexavalent Chromium, Lead, and Methylene Chloride when walking through contamination /regulated area while using the restroom.

2. RECOMMENDATION: Requesting 7 MXG/CC sign all five AF IMT 3s in block 20.

KENNETH H. FETTERS, Maj, USAF
Commander, 7 EMS

1 Tab
AF IMT 3s

AF IMT 1768, 19840901, V5 PREVIOUS EDITION WILL BE USED.

HAZARD ABATEMENT PLAN

TYPE OF ACTION: [X] HAZARD [ ] DEFICIENCY; [X] OCCUPATIONAL [ ] NON-OCCUPATIONAL; [X] NEW [ ] REVISED [ ] COMPLETE

DATE: 20141006

TO:	FROM:	POINT OF CONTACT
7 AMDS/SGPB Dyess AFB	7 EMS/MXMFS Dyess AFB	TSgt Douglas Chaney AUTOVON NUMBER 461-2169

I. HAZARD/DEFICIENCY INFORMATION

1. CONTROL NO.	2. RAC	3. CATEGORY	4. DISCOVERY	
H14-001	2(II,B)	[ ] SAFETY [ ] FIRE [X] HEALTH	a. DATE 20140218 b. METHOD (Check) [X] INSPECTION [ ] HAZARD REPORT	[ ] SUGGESTION [ ] MISHAP REPORT [ ] OTHER (Specify)

LOCATION

5. ORGANIZATION	7. FACILITY NO.	9. STANDARD VIOLATED
7 EMS	8040	UFC 4-211-02, 1 Dec 2012, ch 2, fig 2-5
6. OFFICE SYMBOL	**8. FUNCTION**	**10. EXPOSURE**
MXMFS	Prep/Paint Facility	15-25 personnel per day

11. DESCRIPTION

Hazard can cause unnecessary exposure to personnel when walking through the contaminated/regulated area while using the restroom. If not resolved, hazard can cause chronic illness or serious sickness from OSHA expanded standard chemicals (cadmium, hexavalent chromium, lead, and methylene chloride).

II. ABATEMENT LOCATION

PERMANENT

12. DESCRIPTION

Personnel are required to enter a potentially contaminated/regulated area to use the restroom, due to it being the only one in the facility.
Permanent abatement would be expanding out the office area into the paint bay so that there is enough room to incorporate restrooms and a transition room.

13. METHOD	14. PROJECT NO.	15. COMPLETION DATE	16. COST
Civil-Engineering work order		[ ] ESTIMATED [ ] ACTUAL	[ ] ESTIMATED [ ] ACTUAL

17. STATUS [ ] FUNDED [X] UNFUNDED

A 332 has been signed by squadron CC and submitted up to the MXG to expand current facility to include bathrooms.

a. PROJECT COST

b. ABATEMENT COST

18. INTERIM CONTROL MEASURES

Ensure PPE is utilized at all times within the regulated area during blasting, priming, painting operations. A decontamination trailer has been approved as a temporary fix in interim. The trailer has been delivered and is awaiting hook up to power and water.

19. FUNCTIONAL MANAGER (Typed/Printed Name, Grade, Title)	20. SIGNATURE	21. DATE
RICHARD W. GIBBS, Col, USAF Commander, 7 MXG	Richard W. Gibbs	24 Dec 14

22. REVIEW RECORD										
	INITIALS									
	DATE									

FOR SAFETY/FIRE/HEALTH USE ONLY

23. SEVERITY	24. PROBABILITY	25. MULTIPLIER	26. EXPOSURE	27. PROJECT COST	ABATEMENT PRIORITY NUMBER	
					28. RAC	29. COST EFF INDEX
II	B				2 (II, B)	

30. QUALIFIED OFFICIAL (Typed/Printed Name, Grade, Title)	31. SIGNATURE	32. DATE

HAZARD ABATEMENT PLAN

TYPE OF ACTION						DATE
☒ HAZARD	☒ OCCUPATIONAL	☒ NEW				20141006
☐ DEFICIENCY	☐ NON-OCCUPATIONAL	☐ REVISED				
		☐ COMPLETE				

TO:	FROM:	POINT OF CONTACT
7 AMDS/SGPB Dyess AFB	7 EMS/MXMFS Dyess AFB	TSgt Douglas Chaney AUTOVON NUMBER 461-2169

I. HAZARD/DEFICIENCY INFORMATION

1. CONTROL NO.	2. RAC	3. CATEGORY	4. DISCOVERY		
H14-002	2 (II,B)	☐ SAFETY ☐ FIRE ☒ HEALTH	a. DATE 20140218	☐ SUGGESTION	
			b. METHOD (Check)	☐ MISHAP REPORT	
			☒ INSPECTION	☐ OTHER (Specify)	
			☐ HAZARD REPORT		

LOCATION

5. ORGANIZATION	7. FACILITY NO.	9. STANDARD VIOLATED
7 EMS	8040	UFC 4-211-02, 1 Dec 2012, ch 2, fig 2-5
6. OFFICE SYMBOL	**8. FUNCTION**	**10. EXPOSURE**
MXMFS	Prep/Paint Facility	15-25 personnel per day

11. DESCRIPTION

Hazard can cause unnecessary cross contamination of the administrative area. If not resolved, hazard can cause chronic illness or serious sickness from OSHA expanded standard chemicals (cadmium, hexavalent chromium, lead, and methylene chloride).

II. ABATEMENT LOCATION

PERMANENT

12. DESCRIPTION

No transition area exists from regulated area to the administrative area. This creates a high potential for cross contamination in the admin area.

Permanent abatement would be expanding out the office area into the paint bay so that there is enough room to incorporate restrooms and a transition room.

13. METHOD	14. PROJECT NO.	15. COMPLETION DATE	16. COST
Civil-Engineering work order		☐ ESTIMATED ☐ ACTUAL	☐ ESTIMATED ☐ ACTUAL

17. STATUS ☐ FUNDED ☒ UNFUNDED

A 332 has been signed by squadron CC and submitted up to the MXG to expand current facility to include admin areas.

a. PROJECT COST

b. ABATEMENT COST

18. INTERIM CONTROL MEASURES

A trailer outside the priming side southeast corner exterior door that can be used as a transition area for doffing PPE. Personnel can enter through the ECP after removing their PPE. This decontamination trailer has been approved as a temporary fix. The trailer has been delivered and is awaiting hook up to power and water.

19. FUNCTIONAL MANAGER (Typed/Printed Name, Grade, Title)	20. SIGNATURE	21. DATE
RICHARD W. GIBBS, Col, USAF Commander, 7 MXG	Richard W. Gibbs	24 Dec 14

22. REVIEW RECORD										
INITIALS										
DATE										

FOR SAFETY/FIRE/HEALTH USE ONLY

23. SEVERITY	24. PROBABILITY	25. MULTIPLIER	26. EXPOSURE	27. PROJECT COST	ABATEMENT PRIORITY NUMBER	
					28. RAC	29. COST EFF INDEX
II	B				2 (II, B)	

30. QUALIFIED OFFICIAL (Typed/Printed Name, Grade, Title)	31. SIGNATURE	32. DATE

HAZARD ABATEMENT PLAN

TYPE OF ACTION: [X] HAZARD [ ] DEFICIENCY; [X] OCCUPATIONAL [ ] NON-OCCUPATIONAL; [X] NEW [ ] REVISED [ ] COMPLETE

DATE: 20141006

TO:	FROM:	POINT OF CONTACT
7 AMDS/SGPB Dyess AFB	7 EMS/MXMFS Dyess AFB	TSgt Douglas Chaney AUTOVON NUMBER

I. HAZARD/DEFICIENCY INFORMATION

1. CONTROL NO.	2. RAC	3. CATEGORY	4. DISCOVERY	
H14-004	2 (II,B)	[ ] SAFETY [ ] FIRE [X] HEALTH	a. DATE b. METHOD (Check) [ ] INSPECTION [ ] HAZARD REPORT	[ ] SUGGESTION [ ] MISHAP REPORT [X] OTHER (Specify) Exposure Ass'mt

LOCATION

5. ORGANIZATION	7. FACILITY NO.	9. STANDARD VIOLATED
7 EMS	Bldg 8040	29 CFR 1910.1026(f)(1)(i)
6. OFFICE SYMBOL	**8. FUNCTION**	**10. EXPOSURE**
MXMFS	Priming Operations	2-3 times/week; 4-8 hrs/shift

11. DESCRIPTION

Air sampling conducted by Bioenvironmental Engineering (BE) during priming operations in Bldg 8040 Structural Mx Booth shows that this process exceeds OSHA levels routinely (Sep '13, Nov '13, Mar '14) for the OSHA Expanded Standard hazard, Hexavalent Chromium, or Cr (VI). In-place controls and processes are not sufficient to control the levels of Cr (VI) below OSHA regulations.

II. ABATEMENT LOCATION

PERMANENT

12. DESCRIPTION

The subsequent precautions will be implemented to reduce over-exposure when conducting future priming operations: Workers will avoid priming in close proximity of others to negate overspray exposure. Workers will tape the ends of their nitrile gloves to their tyvek suit to prevent skin exposure around their wrists. Components being sprayed will be rotated as necessary to ensure air flow remains to the worker's back/side at all times. Future air sampling will determine the effectiveness of these measures.

13. METHOD	14. PROJECT NO.	15. COMPLETION DATE	16. COST
Process Change	TBD	[X] ESTIMATED [ ] ACTUAL	[X] ESTIMATED [ ] ACTUAL

17. STATUS [ ] FUNDED [X] UNFUNDED

Seeking approval, awaiting endorsement. Building 8040 is currently being used to restore the protective coatings on Aerospace Ground Equipment and small A/C parts.

a. PROJECT COST

b. ABATEMENT COST

18. INTERIM CONTROL MEASURES

Authorized Structural Mx personnel are educated/trained to the Cr (VI) hazards; only these personnel work in the demarcated Regulated Area for the priming process. Personnel use BE-approved respirator protection, hooded tyvek suits, booties, and nitrile gloves--minimizing skin exposure. The booth's ventilation system is fully operational during the process; personnel are trained to spray primer down-wind unless it is unavoidable. A BE-approved contamination control/housekeeping O.I. is in place. Priming/painting operations are being conducted with the precautions described in item 12 above.

19. FUNCTIONAL MANAGER (Typed/Printed Name, Grade, Title)	20. SIGNATURE	21. DATE
RICHARD W. GIBBS, Col, USAF Commander, 7 MXG	Richard W. Gibbs	24 Dec 14

22. REVIEW RECORD											
	INITIALS										
	DATE										

FOR SAFETY/FIRE/HEALTH USE ONLY

23. SEVERITY	24. PROBABILITY	25. MULTIPLIER	26. EXPOSURE	27. PROJECT COST	ABATEMENT PRIORITY NUMBER	
					28. RAC	29. COST EFF INDEX
II	B				2 (II,B)	

30. QUALIFIED OFFICIAL (Typed/Printed Name, Grade, Title)	31. SIGNATURE	32. DATE

7.3 Appendix C

Remedial Action Report to be inserted behind this sheet upon completion.

Asbestos Survey

Building 8040
1081 2nd Street
Dyess AFB, Taylor County, Texas

Project Number: 6488

February, 2016

Prepared for:
Castillo Architect
981 Southpark Drive
Littleton, CO 80120

Site Inspection:

Mark McHan
Individual Asbestos Consultant
TDSHS License #: 105642
Exp. 07-18-16

Prepared by:

Enprotec / Hibbs & Todd
402 Cedar, Abilene, Texas 79601
Phone: (325) 698-5560 Fax: (325) 691-0058
Website: e-ht.com
PE Firm Registration No. 1151
PG Firm Registration No. 50103
RPLS Firm Registration Nos. 10011900 & 10007300

Building 8040
1081 2nd Street
Dyess AFB, Texas

Table of Contents

EXECUTIVE SUMMARY

Enprotec / Hibbs & Todd, Inc. (eHT) was retained by Castillo Architect to perform an asbestos survey of Building 8040, located at 1081 2nd Street, Dyess AFB, Texas. The asbestos survey was comprehensive in scope to include the entire facility. Based on the assessment results, the following suspect asbestos containing materials were identified:

- Drywall Gypsum Wallboard (DWGB) & Texture;
- Joint Compound;
- 12" x 12" Resilient Floor Tile (RFT) (White with Grey and Pink Streaks) and Yellow Mastic;
- 12" x 12" RFT (White with Brown Spots) and Black Mastic;
- 12" x 12" RFT (Grey) and Black Mastic; and
- Cove Base and Tan Mastic.

The Asbestos Survey was performed on February 23, 2016 by Mark McHan, Individual Asbestos Consultant, license number 105642, expiration date 07/18/16. Thirty six (36) bulk samples of suspect asbestos containing building materials (ACBMs) were collected and submitted to the laboratory for analysis.

Based on laboratory results, asbestos was not found in any of the 36 samples collected in this assessment.

Enprotec / Hibbs & Todd, Inc. recommends the following actions:

- Any suspect building materials not sampled in this assessment encountered during demolition activities should be sampled and tested for possible asbestos content by qualified personnel prior to continuation of demolition activities.

1.0 INTRODUCTION:

1.1 Client/Facility Location

eHT was retained by Castillo Architect, to perform an asbestos survey of Building 8040, located at 1081 2nd Street, Dyess AFB, Texas.

1.2 Scope of Work:

In general, the scope of work included the performance of an asbestos survey on building materials which may be disturbed by planned renovation activities.

The facility was an approximately 11,000 square feet (sq. ft.) metal building on concrete slab foundation on-grade. The exterior was metal. The interior walls were not finished and were covered with fiberglass insulation. The interior housed a paint booth and blast booth that were constructed of metal. An office area and a separate restroom/change area were also housed in the building. These areas were constructed of wood, sheetrock and vinyl floor tile. A sheetrock partition wall separated the north end of the facility from the blasting and painting operations. A sheetrock wall partition was also located along the west wall on the south side of the division wall. The office area was centrally heated and cooled. No suspect asbestos containing materials were noted associated with the central system.

1.3 Regulatory Standards:

This study was conducted based on the Final Rules for Asbestos Exposure in General Industry and Construction, issued August 10, 1994. An employer or owner may demonstrate that Presumed Asbestos Containing Material (PACM) (includes thermal system insulation, sprayed-on or troweled-on surfacing material and debris in work areas where such material is present) does not contain asbestos by having an inspection conducted pursuant to the requirements of Asbestos Hazard Emergency Response Act (AHERA) (40 CFR 763, Subpart E). Such tests shall include analysis of a minimum of three (3) bulk samples of each homogenous area of PACM collected in a randomly distributed manner. The tests, evaluation, and sample collection shall be performed by an accredited inspector or by a Certified Industrial Hygienist (CIH). The employer/building owner may demonstrate that flooring material, including associated mastic and backing, does not contain asbestos, based upon recognized analytical techniques showing that the material is asbestos free (contains 1% or less of asbestos).

State and Federal regulations require an asbestos survey be performed prior to renovation or demolition of a public or commercial building. Renovation and demolition will disturb building materials and the asbestos materials likely to be disturbed must be removed by a qualified (i.e. certified and licensed) asbestos abatement contractor under monitoring and supervision of a qualified asbestos consultant.

Federal and State regulations only allow asbestos material to remain in-place during demolition activities under certain circumstances. The circumstances are: 1) a building is declared to be structurally unsound and in danger of collapse, or 2) regulated materials are removed, leaving only certain non-friable materials in-place. Regulated asbestos-containing materials (RACMs) are ACMs that are friable or may become friable during demolition. Materials that may remain in-place include gaskets, packings, resilient floor coverings, and asphalt roofing materials that are not friable and are not in poor condition (Category 1 Non-Friable ACM), as well as other non-friable materials (Category II Non-Friable ACM) that do not have a high probability of becoming or have not already become crumbled, pulverized or reduced to powder by forces expected to act on the Material in the course of demolition activities.

According to NESHAP [40CFR61.145(A)(3)], a building may be demolished with friable and non-friable ACMs in-place "if the facility is being demolished under an order of a State or Local government agency, issued because the facility is structurally unsound and in danger of imminent collapse". TAHPR similarly stated in 25 TAC 295.61(i), "The judgement that a structure is in danger of imminent collapse or that it is unsafe for anyone to enter shall be made by a professional engineer, registered architect, or government official" and as such the building would no longer meet the requirements of a public building [25 TAC 295.32(7A)(F)]. Leaving the ACMs requires the use of wet demolition techniques and proper disposal of all the resulting debris as asbestos waste.

1.4 Field Methods:

Prior to collecting bulk samples of suspect ACBM, distinct homogeneous sampling areas and specific sampling sites were defined. A homogeneous sample area can be defined as a material that is similar in appearance, color, and generally having the same episode of installation as surrounding "like" material. Attempts were made in all cases to obtain representative samples of like materials, as this is the most cost-effective method for determination of ACBM. It should be assumed by the building owner, contractor, and the abatement contractors that the compositions of like materials in a single homogeneous area are the same.

All accessible areas of the facility were inspected for the presence of ACBM. As the suspect ACBM was located and identified, bulk samples were obtained and placed in labeled individual containers. The sample identification number on the containers directly corresponds with the numbers listed on the Chain-of-Custody (COC) and laboratory reports presented in Appendix A. **In the event that during any renovation or demolition, any suspect material is encountered behind any walls or other areas that were not accessible at the time this survey was conducted, samples of these suspect materials should be collected and analyzed by qualified asbestos inspectors and laboratories, respectively.**

1.5 Assessment of Suspect ACBM:

In accordance with AHERA (October 30, 1986), verified or assumed ACBM discovered in an inspection or reinspection of a facility shall be assessed in view of past, present, or future likelihood of disturbance and may include the following:

- Location of material present;
- Condition of material: type of damage, severity of damage, and the extent or spread of damage;
- Accessibility of the materials;
- Potential for disturbance of the material;
- Known or suspected causes of damage (i.e., air erosion, vandalism, service or repair, vibration, and water);
- Preventative measures which might eliminate the possibility of undamaged ACBM from being significantly damaged; and
- Actions to be taken to protect human health.

1.5.1 Classification of ACBM: Verified ACBM are classified into one of the following categories:

- Damaged ACBM thermal system insulation;
- Significantly damaged ACBM thermal system insulation;
- Damaged friable surfacing ACBM;
- Significantly damaged friable surfacing ACBM;
- Damaged friable miscellaneous ACBM;
- Significantly damaged friable miscellaneous ACBM;
- ACBM with potential for damage;
- ACBM with potential for significant damage; and
- Remaining ACBM not fitting into categories above.

ACBM is defined as friable if the material contains more than one-percent asbestos that, when dry, can be crumbled, pulverized or reduced to powder by hand pressure. ACBM is defined as non-friable if the material contains more than one-percent asbestos that when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure. Friable materials are more likely to become airborne, thereby increasing the potential for health hazards.

1.5.2 Prioritization: The ACBM is usually examined and prioritized according to condition, location, potential for damage and potential or fiber release. The priorities are usually divided into the following categories:

- Low Hazard - those non-friable materials in good condition with low potential for disturbance **(L)**.
- Moderate Hazard - Those currently non-friable or friable materials in good physical condition, that have a moderate potential for disturbance or damage to make them friable and release asbestos fibers to the air **(M)**.
- High Hazard - Those friable or non-friable materials that have become friable in poor physical condition and/or likely to be disturbed by air currents, water damage, construction or other activities which could distribute airborne asbestos fibers **(H)**.
- Immediate Hazard - Those friable or non-friable materials that have become friable, that are significantly damaged, have released material and/or are very likely to expose unprotected persons **(I)**.

1.6 Laboratory Methods:

A total of thirty six (36) bulk samples were collected from the building areas accessed. Polarized Light Microscopy (PLM) methods were utilized with dispersion-staining techniques according to US EPA Method EPA 600/R-93/116. This type of analysis requires the microscopist to take a portion of the bulk sample and treat it with a special light-refractive oil emulsion stain. This prepared slide is then subjected to a variety of tests while being viewed under varying polarization of light.

Each type of asbestos are determined by visual estimation. Even though this is an estimation, any material that contains more than one percent of any type of asbestos using the PLM method is considered an ACBM and must be handled according to OSHA and EPA regulations, if disturbed.

Friable materials may be reanalyzed using the objective point counting method. (Asbestos NESHAP Revision Final Rule to CFR 61.141). The point counting method shall take precedent when different to the standard PLM method.

The samples were submitted to Moody Labs in Farmers Branch, Texas for analysis. This laboratory is a NVLAP accredited laboratory and licensed by the Texas Department of State Health Services.

1.7 Response Actions:

The following four (4) basic response actions are options for each type of ACBM:

- Operations and Maintenance - requires maintenance of the material in an undamaged condition. This includes the repair or removal of damaged materials, record keeping, worker training, re-inspection, prevalent level air monitoring and documentation in a comprehensive Operations and Maintenance Program (O&M) specific to the building.
- Encapsulation - requires sealing of the exposed surface of the ACBM with a bridging-type encapsulant or conversion from a friable to non-friable status with penetrating type encapsulant. Encapsulation work must be conducted under conditions which control the release of asbestos fibers into the building areas.
- Enclosure - requires isolation of the ACBM behind or within air-tight barriers of gypsum wallboard, plyboard, etc. Enclosure work must be conducted under conditions which control the release of asbestos fibers into the building areas.
- Removal - requires removal and disposal of the asbestos-containing building material (ACBM) under full asbestos abatement conditions by licensed asbestos abatement contractors.

2.0 Survey Findings:

The following findings are based on site investigations performed on February 23, 2016. No previous information from historical asbestos surveys were provided to eHT for inclusion in this Report. This asbestos survey was performed in accordance with the Texas Asbestos Health Protection Rules (TAHPR), 25 TAC 295.34.

The following materials were identified as suspect ACBM or Presumed Asbestos Containing Building Materials (PACM):

- Drywall Gypsum Wallboard (DWGB) & Texture;
- Joint Compound;
- 12" x 12" Resilient Floor Tile (RFT) (White with Grey and Pink Streaks) and Yellow Mastic;
- 12" x 12" RFT (White with Brown Spots) and Black Mastic;
- 12" x 12" RFT (Grey) and Black Mastic; and
- Cove Base and Tan Mastic.

Materials observed but not suspected of containing asbestos were not sampled. The non-sampled materials included fiberglass insulation, metal products, glass materials, plastic products and wood materials. A table presenting a summary of the samples collected is presented as Table 1 in the Tables Section. The sample locations are shown on Figure 1 in the Figures Section.

The building was viewed at 1081 2nd Street, Dyess AFB, Texas on February 23, 2016 by Mark McHan, TDSHS Individual Asbestos Consultant, license no.: 105642. The survey was comprehensive in scope. A total of 36 bulk samples of suspect ACBM materials were collected at this location. The laboratory reports are presented in Appendix B.

2.1 Laboratory Results:

Based on laboratory results, asbestos was not found in any of the 36 samples collected in this assessment.

3.0 RECOMMENDATIONS:

- This survey was non-destructive in nature. Therefore, if any suspect material not sampled in this assessment is encountered during any building/demolition activities, it should be 4sampled and tested for possible asbestos content by qualified personnel prior to the continuation of these activities.

- Any areas not addressed in this assessment should be checked for suspect asbestos materials before any renovation, and/or demolition activities are to take place. Sampling and assessing of the suspect materials should be conducted by qualified personnel.

4.0 STANDARDS/LIMITATIONS:

The work performed in conjunction with the data developed are intended as a description of available information at the dates and locations given. This report does not warrant against future operations or conditions, nor does it warrant against operations or conditions present of a type or at a location not investigated.

Opinions and recommendations presented herein apply to site conditions existing at the time of our investigation and those reasonable foreseeable; they cannot necessarily apply to site changes of which Enprotec is not aware and has not had the opportunity to evaluate.

This report is designed to aid the building owner, architect, construction manager, general contractor, and potential abatement contractor in locating ACBM. Under no circumstances is this report to be used as a bidding document or a project specification document.

Reasonable efforts were made to obtain representative samples of building materials and have those materials analyzed for asbestos content. Materials or conditions which were not observed due to the survey conditions stated herein may differ from those documented in this report. Should suspect materials be discovered during building renovation/demolition that have not been addressed, bulk samples of the material should be collected and analyzed for asbestos content prior to renovation and/or demolition.

Our professional services have been performed, our findings obtained, and recommendations prepared in accordance with customary principles and practices in the fields of environmental science and engineering. This warranty is in lieu of all other warranties either expressed or implied. Enprotec is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

Tables:
Table 1, Suspect ACM Summary

TABLE 1
SUSPECT ACBM SUMMARY

Building 8040
1081 2nd Street
Dyess AFB, Texas

Sample No:	Material	Location	Type (S,TSI,M)	Friable/Nonfriable (F/NF)	Category Class. (1 - 9)	Priority (1 - 4)	Response Action (1 - 4)	Asbestos Content (ND=Non Detect)
001	DWGB & Texture	Office Area						ND
002	DWGB & Texture	Office Area						ND
003	DWGB & Texture	Office Area						ND
004	Joint Compound	Office Area						ND
005	Joint Compound	Office Area						ND
006	Joint Compound	Office Area						ND
007	12" x 12" White with Grey & Pink Steaks RFT & Yellow Mastic	Office Area						ND
008	12" x 12" White with Grey & Pink Steaks RFT & Yellow Mastic	Office Area						ND
009	12" x 12" White with Grey & Pink Steaks RFT & Yellow Mastic	Office Area						ND
010	Cove Base & Tan Mastic	Office Area						ND
011	Cove Base & Tan Mastic	Office Area						ND
012	Cove Base & Tan Mastic	Office Area						ND
013	DWGB & Texture	Restroom / Shower Area						ND
014	DWGB & Texture	Restroom / Shower Area						ND
015	DWGB & Texture	Restroom / Shower Area						ND
016	Joint Compound	Restroom / Shower Area						ND
017	Joint Compound	Restroom / Shower Area						ND
018	Joint Compound	Restroom / Shower Area						ND
019	12" x 12" White with Brown Spots RFT & Black Mastic	Restroom / Shower Area						ND
020	12" x 12" White with Brown Spots RFT & Black Mastic	Restroom / Shower Area						ND
021	12" x 12" White with Brown Spots RFT & Black Mastic	Restroom / Shower Area						ND

Type		Category Classification:	Response Action:	Priority:
S	Surfacing Material	1. Damaged ACBM thermal System Insulation	1. Operations and Maintenance	1. Low Hazard
TSI	Thermal System Insulation	2. Significantly Damaged ACBM Thermal System Insulation	2. Encapsulation	2. Moderate Hazard
M	Miscellaneous Material	3. Damaged Friable Surfacing ACBM	3. Enclosure	3. High Hazard
		4. Significantly Damaged Friable Surfacing ACBM	4. Removal	4. Immediate Hazard
		5. Damaged Friable Miscellaneous ACBM		
		6. Significantly Damaged Friable Miscellaneous ACBM		
		7. ACBM With Potential For Damage		
		8. ACBM With Potential For Significant Damage		
		9. Remaining ACBM Not Fitting Into Categories Above		

Note:

Asbestos Type, Category Classification, Priority and Response Action are not given for Non ACBMs listed on the table.

TABLE 1
SUSPECT ACBM SUMMARY

Building 8040
1061 2nd Street
Dyess AFB, Texas

Sample No:	Material	Location	Type (S,TSI,M)	Friable/Nonfriable (F/NF)	Category Class. (1 - 9)	Priority (1 - 4)	Response Action (1 - 4)	Asbestos Content (ND=Non Detect)
022	12" x 12" Grey RFT & Black Mastic	Restroom / Shower Area						ND
023	12" x 12" Grey RFT & Black Mastic	Restroom / Shower Area						ND
024	12" x 12" Grey RFT & Black Mastic	Restroom / Shower Area						ND
025	DWGB & Texture	Divider Wall						ND
026	DWGB & Texture	Divider Wall						ND
027	DWGB & Texture	Divider Wall						ND
028	Joint Compound	Divider Wall						ND
029	Joint Compound	Divider Wall						ND
030	Joint Compound	Divider Wall						ND
031	DWGB & Texture	West Wall						ND
032	DWGB & Texture	West Wall						ND
033	DWGB & Texture	West Wall						ND
034	Joint Compound	West Wall						ND
035	Joint Compound	West Wall						ND
036	Joint Compound	West Wall						ND

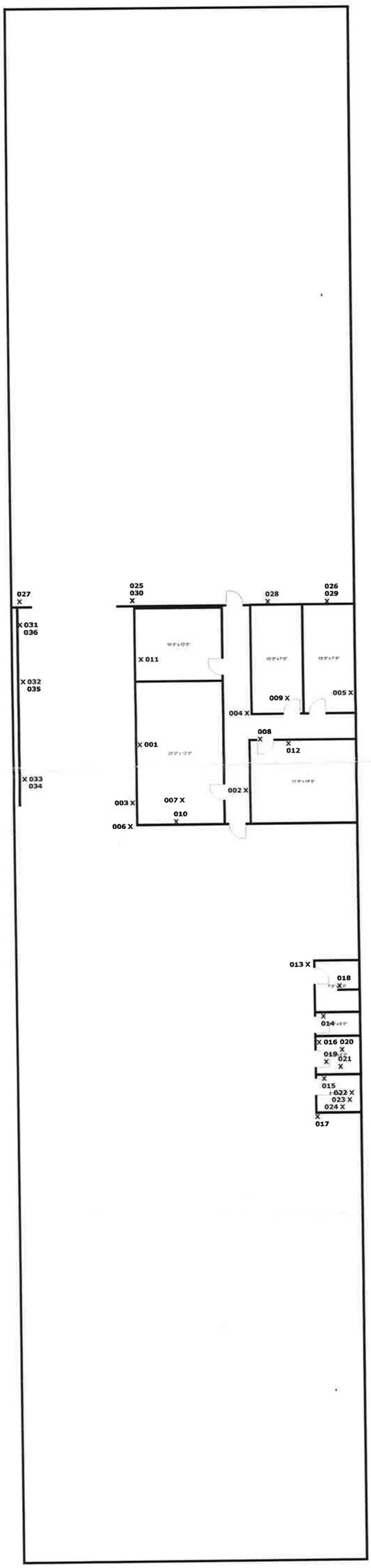
Type		Category Classification:	Response Aciton:	Priority:
S	Surfacing Material	1. Damaged ACBM thermal System Insulation	1. Operations and Maintenance	1. Low Hazard
TSI	Thermal System Insulation	2. Significantly Damaged ACBM Thermal System Insulation	2. Encapsulation	2. Moderate Hazard
M	Miscellaneous Material	3. Damaged Friable Surfacing ACBM	3. Enclosure	3. High Hazard
		4. Significantly Damaged Friable Surfacing ACBM	4. Removal	4. Immediate Hazard
		5. Damaged Friable Miscellaneous ACBM		
		6. Significantly Damaged Friable Miscellaneous ACBM		
		7. ACBM With Potential For Damage		
		8. ACBM With Potential For Significant Damage		
		9. Remaining ACBM Not Fitting into Categories Above		

Note:

Asbestos Type, Category Classification, Priority and Response Action are not given for Non ACBMs listed on the table.

Figures:
Figure 1, Sample Location Layout

FIGURE 1
SAMPLE LOCATION LAYOUT
BUILDING 8040
1081 2ND STREET
ABILENE, TEXAS



LEGEND:
X = SAMPLE LOCATION
001 = SAMPLE ID

Appendix A - Terminology
Abbreviations/Definitions

CWP .....Chilled water pipe insulation (straight run)
CWF .....Chilled water fitting insulation
CWSP.....Chilled water supply pipe insulation (straight run)
CWSF.....Chilled water supply fitting insulation
CWRP.....Chilled water return pipe insulation (straight run)
CWRF.....Chilled water return fitting insulation
HWP .....Heating water pipe insulation (straight run)
HWF .....Heating water fitting insulation
HWSP.....Heating water supply pipe insulation (straight run)
HWSF.....Heating water supply fitting insulation
HWRP.....Heating water return pipe insulation (straight run)
HWRF.....Heating water return fitting insulation
HCP .....Heating/chilled water pipe insulation (straight run)
HCF .....Heating/chilled water fitting insulation
HCSP.....Heating/chilled water supply pipe insulation (straight run)
HCSF.....Heating/chilled water supply fitting insulation
HCRP.....Heating/chilled water return pipe insulation (straight run)
HCRF.....Heating/chilled water return fitting insulation
SP .....Steam pipe insulation (straight run)
SF .....Steam fitting insulation
LPSP.....Low pressure steam pipe insulation (straight run)
LPSF.....Low pressure steam fitting insulation
HPSP.....High pressure steam pipe insulation (straight run)
HPSF.....High pressure steam fitting insulation
SCP .....Steam condensate pipe insulation (straight run)
SCF .....Steam condensate fitting insulation
DWP .....Domestic water pipe insulation (straight run)
DWF .....Domestic water fitting insulation
DCWP.....Domestic cold water pipe insulation (straight run)
DCWF.....Domestic cold water fitting insulation
DHWP.....Domestic hot water pipe insulation (straight run)
DHWF.....Domestic hot water fitting insulation
RDP .....Roof drain pipe insulation (straight run)
RDF .....Roof drain fitting insulation
MP .....Miscellaneous pipe insulation (straight run)
MF .....Miscellaneous fitting insulation

M I S C E L L A N E O U S M A T E R I A L S

FRBK.....Fibrous backing material
MS .....Mastic (miscellaneous or unidentified source)
SOIL.....Soil, dirt, fill
ELEC.....Electrical components (fixture backing, breaker insulators)
MISC.....Miscellaneous material (not fitting into other categories)

FP .....Structural fireproofing (sprayed-on, trowelled)
AP .....Acoustical plaster (sprayed or trowelled on plaster base)
AT .....Acoustical texture (on gypsum board, concrete base, etc)
HP .....Hard finish plaster or stucco
SAT .....Suspended acoustical tiles (lay-in, concealed spline)
AAT .....Adhered acoustical tiles (ceilings, walls)
ATMS.....Mastic on acoustical tiles
DW .....Drywall construction
DWGB.....Drywall gypsum wallboard
DWTX.....Drywall texture (rolled or brushed)
DWJC.....Drywall joint compound (tape and bed mud)
PFBD.....Pre-formed fiberboard (Tectum, Celotex, Masonite)
MTX .....Miscellaneous texture material (heavy coatings)
CFB .....Cement fiber board (roof, soffit, ceiling, wall panels)
CFP .....Cement fiber pipe (flues, pipes)
RFT .....Resilient floor tiles
FTMS.....Mastic on resilient floor tiles
RSF .....Resilient sheet flooring
SFMS.....Mastic on resilient sheet flooring
RB .....Resilient base, nosings, trim
RBMS.....Mastic on resilient base, nosings, trim
TBI .....Thermal building insulation (sprayed-on,blown,batts,sheets)
BUR .....Built-up roofing (felts, mastic and gravel typical)
RFLS.....Roof flashing (felts or mastic)
RSHG.....Roof shingles
DB .....Debris (on floor, equipment, fixture surfaces)
FAB .....Fabric material (curtains, wall fabrics, etc)

M E C H A N I C A L E Q U I P M E N T

AH .....Air handler unit insulation
AHMB.....Air handler main body insulation
AHND.....Air handler end insulation
AHFL.....Air handler flue insulation
DT .....Duct insulation
DTMS.....Mastic on duct insulation
DTIS.....Duct vibration isolator (flexible connection)
BL .....Boiler unit insulation
BLMB.....Boiler main body insulation
BLND.....Boiler end insulation
BLFL.....Boiler flue insulation
CH .....Chiller unit insulation
CHMB.....Chiller main body insulation
CHND.....Chiller end insulation
FL .....Flue insulation (unidentified source)
FLMS.....Mastic on flue insulation
HX .....Heat exchanger unit insulation
HXMB.....Heat exchanger main body insulation
HXND.....Heat exchanger end insulation
ST .....Storage tank unit insulation
STMB.....Storage tank main body insulation
STND.....Storage tank end insulation
GSKT.....Gasket material

Appendix B - Survey Documentation
Laboratory Reports

PLM Summary Report

Moody Labs
2051 Valley View Lane
Farmers Branch, TX 75234 Phone: (972) 241-8460

NVLAP Lab Code 102056-0
TDSHS License No. 30-0084

Client : Enprotec / Hibbs & Todd, Inc. - Abilene
Project : Dyess AFB Building 8040
Project # : 6488
Identification : Asbestos, Bulk Sample Analysis
Test Method : Polarized Light Microscopy / Dispersion Staining (PLM/DS)
EPA Method 600 / R-93 / 116

Lab Job No. : 16B-02294
Report Date : 02/26/2016
Sample Date :02/23/016

On 2/25/2016, thirty six (36) bulk material samples were submitted by Mark McHan of Enprotec / Hibbs & Todd, Inc. - Abilene for asbestos analysis by PLM/DS. The PLM Detail Report is attached; additional information may be found therein. The results are summarized below:

Sample Number	Client Sample Description / Location	Asbestos Content
001	Drywall Gypsum Board and Texture, Office Area	None Detected - Drywall Material None Detected - Texture
002	Drywall Gypsum Board and Texture, Office Area	None Detected - Drywall Material None Detected - Texture
003	Drywall Gypsum Board and Texture, Office Area	None Detected - Drywall Material None Detected - Texture
004	Joint Compound, Office Area	None Detected - Joint Compound
005	Joint Compound, Office Area	None Detected - Drywall Material None Detected - Joint Compound
006	Joint Compound, Office Area	None Detected - Joint Compound
007	12" x 12" Resilient Floor Tile (White with Grey and Pink Streaks), Office Area	None Detected - Floor Tile None Detected - Yellow Mastic
008	12" x 12" Resilient Floor Tile (White with Grey and Pink Streaks), Office Area	None Detected - Floor Tile None Detected - Yellow Mastic
009	12" x 12" Resilient Floor Tile (White with Grey and Pink Streaks), Office Area	None Detected - Floor Tile None Detected - Yellow Mastic
010	Cove Base and Mastic, Office Area	None Detected - Cove Base None Detected - Tan Mastic
011	Cove Base and Mastic, Office Area	None Detected - Cove Base None Detected - Tan Mastic
012	Cove Base and Mastic, Office Area	None Detected - Cove Base None Detected - Tan Mastic
013	Drywall Gypsum Board and Texture, Restroom / Shower Area	None Detected - Drywall Material None Detected - Texture
014	Drywall Gypsum Board and Texture, Restroom / Shower Area	None Detected - Drywall Material None Detected - Texture
015	Drywall Gypsum Board and Texture, Restroom / Shower Area	None Detected - Drywall Material None Detected - Texture

PLM Summary Report

Moody Labs
2051 Valley View Lane
Farmers Branch, TX 75234 Phone: (972) 241-8460

NVLAP Lab Code 102056-0
TDSHS License No. 30-0084

Client : Enprotec / Hibbs & Todd, Inc. - Abilene
Project : Dyess AFB Building 8040
Project # : 6488
Identification : Asbestos, Bulk Sample Analysis
Test Method : Polarized Light Microscopy / Dispersion Staining (PLM/DS)
EPA Method 600 / R-93 / 116

Lab Job No. : 16B-02294
Report Date : 02/26/2016
Sample Date :02/23/016

On 2/25/2016, thirty six (36) bulk material samples were submitted by Mark McHan of Enprotec / Hibbs & Todd, Inc. - Abilene for asbestos analysis by PLM/DS. The PLM Detail Report is attached; additional information may be found therein. The results are summarized below:

Sample Number	Client Sample Description / Location	Asbestos Content
016	Joint Compound, Restroom / Shower Area	None Detected - Drywall Material None Detected - Joint Compound
017	Joint Compound, Restroom / Shower Area	None Detected - Joint Compound
018	Joint Compound, Restroom / Shower Area	None Detected - Joint Compound
019	12" x 12" Resilient Floor Tile (White with Brown Spots), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
020	12" x 12" Resilient Floor Tile (White with Brown Spots), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
021	12" x 12" Resilient Floor Tile (White with Brown Spots), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
022	12" x 12" Resilient Floor Tile (Grey), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
023	12" x 12" Resilient Floor Tile (Grey), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
024	12" x 12" Resilient Floor Tile (Grey), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
025	Drywall Gypsum Board and Texture, Divider Wall	None Detected - Drywall Material None Detected - Texture
026	Drywall Gypsum Board and Texture, Divider Wall	None Detected - Drywall Material None Detected - Paint
027	Drywall Gypsum Board and Texture, Divider Wall	None Detected - Drywall Material None Detected - Paint
028	Joint Compound, Divider Wall	None Detected - Drywall Material None Detected - Joint Compound
029	Joint Compound, Divider Wall	None Detected - Drywall Material None Detected - Joint Compound
030	Joint Compound, Divider Wall	None Detected - Drywall Material None Detected - Joint Compound

PLM Summary Report

Moody Labs
2051 Valley View Lane
Farmers Branch, TX 75234 Phone: (972) 241-8460

NVLAP Lab Code 102056-0
TDSHS License No. 30-0084

Client :	Enprotec / Hibbs & Todd, Inc. - Abilene	Lab Job No. :	16B-02294
Project :	Dyess AFB Building 8040	Report Date :	02/26/2016
Project # :	6488	Sample Date :	02/23/016
Identification :	Asbestos, Bulk Sample Analysis		
Test Method :	Polarized Light Microscopy / Dispersion Staining (PLM/DS) EPA Method 600 / R-93 / 116		

On 2/25/2016, thirty six (36) bulk material samples were submitted by Mark McHan of Enprotec / Hibbs & Todd, Inc. - Abilene for asbestos analysis by PLM/DS. The PLM Detail Report is attached; additional information may be found therein. The results are summarized below:

Sample Number	Client Sample Description / Location	Asbestos Content
031	Drywall Gypsum Board and Texture, West Wall	None Detected - Drywall Material None Detected - Texture
032	Drywall Gypsum Board and Texture, West Wall	None Detected - Drywall Material None Detected - Texture
033	Drywall Gypsum Board and Texture, West Wall	None Detected - Drywall Material None Detected - Texture
034	Joint Compound, West Wall	None Detected - Joint Compound
035	Joint Compound, West Wall	None Detected - Joint Compound
036	Joint Compound, West Wall	None Detected - Joint Compound
017 (QC)	Joint Compound, Restroom / Shower Area	None Detected - Joint Compound
019 (QC)	12" x 12" Resilient Floor Tile (White with Brown Spots), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
023 (QC)	12" x 12" Resilient Floor Tile (Grey), Restroom / Shower Area	None Detected - Floor Tile None Detected - Black Mastic
028 (QC)	Joint Compound, Divider Wall	None Detected - Drywall Material None Detected - Joint Compound

These samples were analyzed by layers. Quantification, unless otherwise noted, is performed by calibrated visual estimate. The test report shall not be reproduced, except in full, without written approval of the laboratory. The results relate only to the items tested. These test results do not imply endorsement by NVLAP or any agency of the U.S. Government. Accredited by the National Voluntary Laboratory Accreditation Program for Bulk Asbestos Fiber Analysis under Lab Code 102056-0.

NVLAP LAB #102056-0

Analyst(s): Brian R. Schmidt

Lab Manager : Heather Lopez — Approved Signatory : Heather Lopez

Lab Director : Bruce Crabb — Approved Signatory : Bruce Crabb

Thank you for choosing Moody Labs

Appendix C - License Documentation
Inspector's License Documents
Laboratory's License Documents

TEXAS DEPARTMENT OF STATE HEALTH SERVICES

STEVE MOODY MICRO SERVICES LLC

is certified to perform as a

Asbestos Laboratory
PCM, PLM, TEM

in the State of Texas within the purview of Texas Occupations Code, chapter 1954, so long as this license is not suspended or revoked and is renewed according to the rules adopted by the Texas Board of Health.

DAVID LAKEY, M.D.
COMMISSIONER OF HEALTH

License Number: 300084

Expiration Date: 5/31/2016

Control Number: 95960

(Void After Expiration Date)

VOID IF ALTERED NON-TRANSFERABLE

MEH Fire Protection Engineering LLC

MEH Fire Prot. Engineering
1311 River Oaks Drive
Flower Mound, TX 75028
972-874-2662

Job Name	:	DAFB Building 8040; Remote Area #1
Building	:	
Location	:	
System	:	
Contract	:	
Data File	:	Remote Area #1 - TREE.WXF

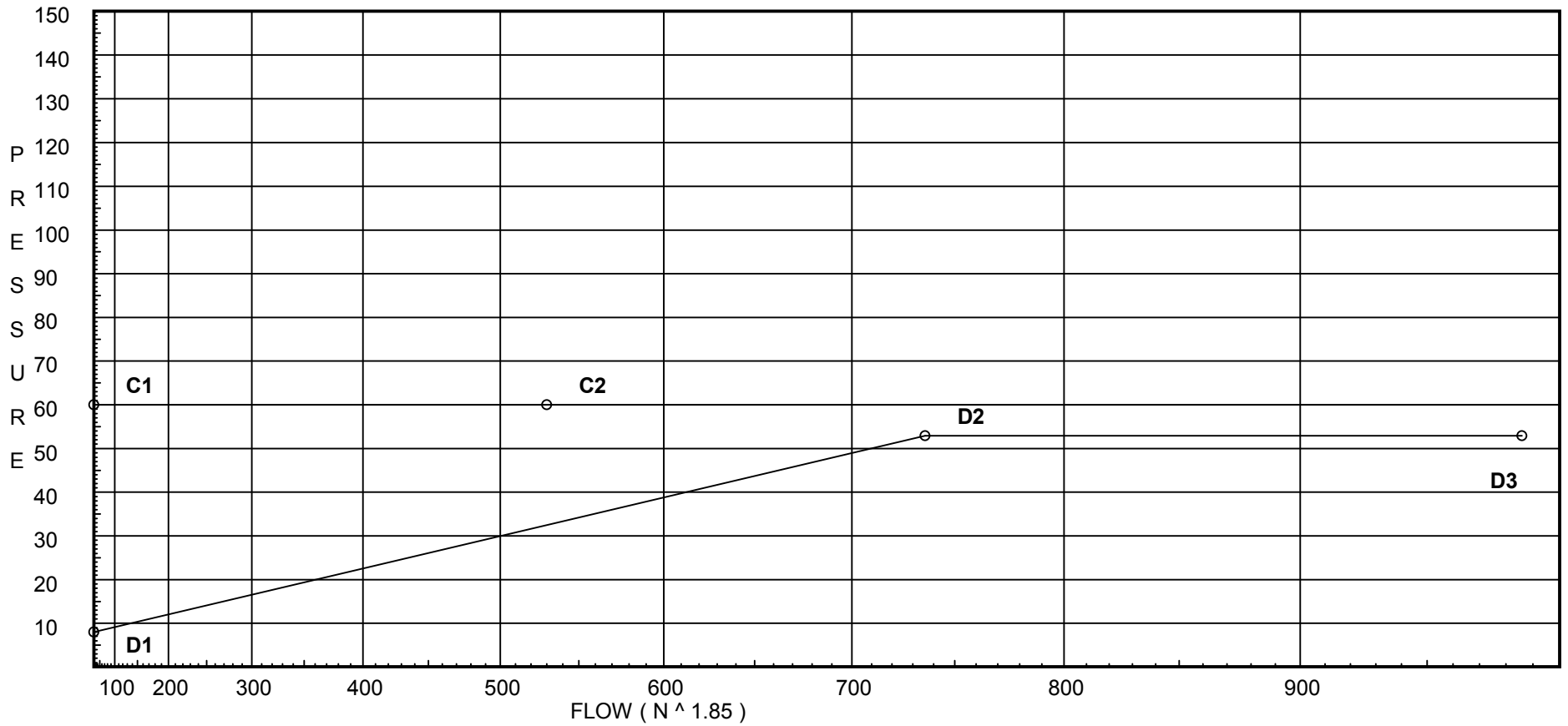
Water Supply Curve (C)

MEH Fire Prot. Engineering
DAFB Building 8040; Remote Area #1

Date 8/18/16

City Water Supply:
- C1 - Static Pressure : 60
- C2 - Residual Pressure: 60
- C2 - Residual Flow : 530

Demand:
- D1 - Elevation : 8.012
- D2 - System Flow : 735.962
- D2 - System Pressure : 52.896
- Hose (Demand) : 250
- D3 - System Demand : 985.962
- Safety Margin : 7.104



Fittings Used Summary

Fitting Legend

Abbrev.	Name	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20	24
E	NFPA 13 90' Standard Elbow	1	2	2	3	4	5	6	7	8	10	12	14	18	22	27	35	40	45	50	61
G	NFPA 13 Gate Valve	0	0	0	0	0	1	1	1	1	2	2	3	4	5	6	7	8	10	11	13
T	NFPA 13 90' Flow thru Tee	3	4	5	6	8	10	12	15	17	20	25	30	35	50	60	71	81	91	101	121

Units Summary

Diameter Units	Inches
Length Units	Feet
Flow Units	US Gallons per Minute
Pressure Units	Pounds per Square Inch

Note: Fitting Legend provides equivalent pipe lengths for fittings types of various diameters. Equivalent lengths shown are standard for actual diameters of Sched 40 pipe and CFactors of 120 except as noted with *. The fittings marked with a * show equivalent lengths values supplied by manufacturers based on specific pipe diameters and CFactors and they require no adjustment. All values for fittings not marked with a * will be adjusted in the calculation for CFactors of other than 120 and diameters other than Sched 40 per NFPA.

Pressure / Flow Summary - STANDARD

Node No.	Elevation	K-Fact	Pt Actual	Pn	Flow Actual	Density	Area	Press Req.
1	15.0	8	10.25	na	25.61	0.2	120	7.0
2	18.5	8	9.0	na	24.0	0.2	120	7.0
3	18.5	8	10.61	na	26.05	0.2	120	7.0
4	15.0	8	14.11	na	30.05	0.2	120	7.0
5	15.0	8	10.26	na	25.63	0.2	120	7.0
6	18.5	8	9.02	na	24.02	0.2	120	7.0
7	18.5	8	10.62	na	26.08	0.2	120	7.0
8	15.0	8	14.13	na	30.08	0.2	120	7.0
9	15.0	8	10.32	na	25.7	0.2	120	7.0
10	18.5	8	9.08	na	24.1	0.2	120	7.0
11	18.5	8	10.69	na	26.16	0.2	120	7.0
12	15.0	8	14.22	na	30.16	0.2	120	7.0
13	15.0	8	10.45	na	25.86	0.2	120	7.0
14	18.5	8	9.21	na	24.27	0.2	120	7.0
15	18.5	8	10.84	na	26.34	0.2	120	7.0
16	15.0	8	14.39	na	30.35	0.2	120	7.0
17	15.0	8	10.67	na	26.13	0.2	120	7.0
18	18.5	8	9.43	na	24.56	0.2	120	7.0
19	18.5	8	11.1	na	26.65	0.2	120	7.0
20	15.0	8	14.69	na	30.66	0.2	120	7.0
21	15.0	8	10.99	na	26.53	0.2	120	7.0
22	18.5	8	9.76	na	25.0	0.2	120	7.0
23	18.5	8	11.49	na	27.11	0.2	120	7.0
24	15.0	8	15.14	na	31.13	0.2	120	7.0
25	18.5	8	13.93	na	29.86	0.2	120	7.0
26	18.5	8	14.56	na	30.52	0.2	120	7.0
27	15.0	8	17.38	na	33.35	0.2	120	7.0
A1	13.0		20.05	na				
A2	13.0		20.08	na				
A3	13.0		20.19	na				
A4	13.0		20.43	na				
A5	13.0		20.83	na				
A6	13.0		21.44	na				
PB3	13.0		21.99	na				
A7	13.0		22.31	na				
A8	13.0		23.42	na				
A9	13.0		24.54	na				
A10	13.0		25.65	na				
A11	13.0		26.77	na				
A12	13.0		27.88	na				
A13	13.0		28.99	na				
A14	13.0		30.11	na				
A15	13.0		31.22	na				
A16	13.0		32.34	na				
A17	13.0		33.45	na				
A50	13.0		36.5	na				
TOR	8.0		40.04	na				
BOR	1.0		48.19	na				
TEST	0.0		52.9	na	250.0			

The maximum velocity is 16.57 and it occurs in the pipe between nodes A7 and A8

Hyd. Ref. Point	Qa Qt	Dia. "C" Pf/Ft	Fitting or Eqv.	Ln.	Pipe Ftng's Total	Pt Pe Pf	Pt Pv Pn	******* Notes ******
1	25.61	1.682		0.0	13.000	10.248		K Factor = 8.00
to		120.0		0.0	0.0	-1.516		
2	25.61	0.0206		0.0	13.000	0.268		Vel = 3.70
2	24.00	1.682	2E	9.9	13.000	9.000		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
3	49.61	0.0701		0.0	22.900	1.605		Vel = 7.16
3	26.05	1.682		0.0	13.000	10.605		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
4	75.66	0.1530		0.0	13.000	1.989		Vel = 10.92
4	30.05	1.682	1E	4.95	3.000	14.110		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A1	105.71	0.2841		0.0	17.850	5.072		Vel = 15.26
	0.0							
	105.71					20.048		K Factor = 23.61
5	25.63	1.682		0.0	13.000	10.264		K Factor = 8.00
to		120.0		0.0	0.0	-1.516		
6	25.63	0.0207		0.0	13.000	0.269		Vel = 3.70
6	24.02	1.682	2E	9.9	13.000	9.017		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
7	49.65	0.0702		0.0	22.900	1.608		Vel = 7.17
7	26.08	1.682		0.0	13.000	10.625		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
8	75.73	0.1532		0.0	13.000	1.992		Vel = 10.93
8	30.07	1.682	1E	4.95	3.000	14.133		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A2	105.8	0.2846		0.0	17.850	5.080		Vel = 15.28
	0.0							
	105.80					20.079		K Factor = 23.61
9	25.70	1.682		0.0	13.000	10.324		K Factor = 8.00
to		120.0		0.0	0.0	-1.516		
10	25.7	0.0208		0.0	13.000	0.270		Vel = 3.71
10	24.11	1.682	2E	9.9	13.000	9.078		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
11	49.81	0.0706		0.0	22.900	1.617		Vel = 7.19
11	26.16	1.682		0.0	13.000	10.695		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
12	75.97	0.1542		0.0	13.000	2.004		Vel = 10.97
12	30.16	1.682	1E	4.95	3.000	14.215		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A3	106.13	0.2862		0.0	17.850	5.109		Vel = 15.32
	0.0							
	106.13					20.190		K Factor = 23.62
13	25.86	1.682		0.0	13.000	10.450		K Factor = 8.00
to		120.0		0.0	0.0	-1.516		
14	25.86	0.0210		0.0	13.000	0.273		Vel = 3.73
14	24.27	1.682	2E	9.9	13.000	9.207		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
15	50.13	0.0715		0.0	22.900	1.637		Vel = 7.24

Hyd. Ref. Point	Qa Qt	Dia. "C" Pf/Ft	Fitting or Eqv.	Ln.	Pipe Ftng's Total	Pt Pe Pf	Pt Pv Pn	******* Notes ******
15	26.35	1.682		0.0	13.000	10.844		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
16	76.48	0.1561		0.0	13.000	2.029		Vel = 11.04
16	30.34	1.682	1E	4.95	3.000	14.389		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A4	106.82	0.2897		0.0	17.850	5.171		Vel = 15.42
	0.0							
	106.82					20.426		K Factor = 23.64
17	26.13	1.682		0.0	13.000	10.665		K Factor = 8.00
to		120.0		0.0	0.0	-1.516		
18	26.13	0.0215		0.0	13.000	0.279		Vel = 3.77
18	24.56	1.682	2E	9.9	13.000	9.428		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
19	50.69	0.0729		0.0	22.900	1.670		Vel = 7.32
19	26.65	1.682		0.0	13.000	11.098		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
20	77.34	0.1594		0.0	13.000	2.072		Vel = 11.17
20	30.66	1.682	1E	4.95	3.000	14.686		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A5	108.0	0.2956		0.0	17.850	5.276		Vel = 15.59
	0.0							
	108.00					20.828		K Factor = 23.66
21	26.53	1.682		0.0	13.000	10.994		K Factor = 8.00
to		120.0		0.0	0.0	-1.516		
22	26.53	0.0220		0.0	13.000	0.286		Vel = 3.83
22	24.99	1.682	2E	9.9	13.000	9.764		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
23	51.52	0.0752		0.0	22.900	1.721		Vel = 7.44
23	27.12	1.682		0.0	13.000	11.485		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
24	78.64	0.1644		0.0	13.000	2.137		Vel = 11.35
24	31.12	1.682	1E	4.95	3.000	15.138		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A6	109.76	0.3046		0.0	17.850	5.437		Vel = 15.85
	0.0							
	109.76					21.441		K Factor = 23.70
25	29.86	1.682	2E	9.9	13.000	13.928		K Factor = 8.00
to		120.0		0.0	9.900	0.0		
26	29.86	0.0274		0.0	22.900	0.627		Vel = 4.31
26	30.52	1.682		0.0	13.000	14.555		K Factor = 8.00
to		120.0		0.0	0.0	1.516		
27	60.38	0.1008		0.0	13.000	1.310		Vel = 8.72
27	33.35	1.682	1E	4.95	3.000	17.381		K Factor = 8.00
to		120.0	1T	9.9	14.850	0.866		
A7	93.73	0.2275		0.0	17.850	4.060		Vel = 13.53
	0.0							
	93.73					22.307		K Factor = 19.85

Hyd. Ref. Point	Qa Qt	Dia. "C" Pf/Ft	Fitting or Eqv.	Ln.	Pipe Ftng's Total	Pt Pe Pf	Pt Pv Pn	******* Notes ******
A1	105.71	4.26	0.0		10.000	20.048		
to		120.0	0.0		0.0	0.0		
A2	105.71	0.0031	0.0		10.000	0.031		Vel = 2.38
A2	105.81	4.26	0.0		10.000	20.079		
to		120.0	0.0		0.0	0.0		
A3	211.52	0.0111	0.0		10.000	0.111		Vel = 4.76
A3	106.13	4.26	0.0		10.000	20.190		
to		120.0	0.0		0.0	0.0		
A4	317.65	0.0236	0.0		10.000	0.236		Vel = 7.15
A4	106.82	4.26	0.0		10.000	20.426		
to		120.0	0.0		0.0	0.0		
A5	424.47	0.0402	0.0		10.000	0.402		Vel = 9.55
A5	108.00	4.26	0.0		10.000	20.828		
to		120.0	0.0		0.0	0.0		
A6	532.47	0.0613	0.0		10.000	0.613		Vel = 11.99
A6	109.76	4.26	0.0		6.300	21.441		
to		120.0	0.0		0.0	0.0		
PB3	642.23	0.0867	0.0		6.300	0.546		Vel = 14.46
PB3	0.0	4.26	0.0		3.700	21.987		
to		120.0	0.0		0.0	0.0		
A7	642.23	0.0865	0.0		3.700	0.320		Vel = 14.46
A7	93.73	4.26	0.0		10.000	22.307		
to		120.0	0.0		0.0	0.0		
A8	735.96	0.1115	0.0		10.000	1.115		Vel = 16.57
A8	0.0	4.26	0.0		10.000	23.422		
to		120.0	0.0		0.0	0.0		
A9	735.96	0.1114	0.0		10.000	1.114		Vel = 16.57
A9	0.0	4.26	0.0		10.000	24.536		
to		120.0	0.0		0.0	0.0		
A10	735.96	0.1115	0.0		10.000	1.115		Vel = 16.57
A10	0.0	4.26	0.0		10.000	25.651		
to		120.0	0.0		0.0	0.0		
A11	735.96	0.1115	0.0		10.000	1.115		Vel = 16.57
A11	0.0	4.26	0.0		10.000	26.766		
to		120.0	0.0		0.0	0.0		
A12	735.96	0.1114	0.0		10.000	1.114		Vel = 16.57
A12	0.0	4.26	0.0		10.000	27.880		
to		120.0	0.0		0.0	0.0		
A13	735.96	0.1115	0.0		10.000	1.115		Vel = 16.57
A13	0.0	4.26	0.0		10.000	28.995		
to		120.0	0.0		0.0	0.0		
A14	735.96	0.1114	0.0		10.000	1.114		Vel = 16.57
A14	0.0	4.26	0.0		10.000	30.109		
to		120.0	0.0		0.0	0.0		
A15	735.96	0.1115	0.0		10.000	1.115		Vel = 16.57
A15	0.0	4.26	0.0		10.000	31.224		
to		120.0	0.0		0.0	0.0		
A16	735.96	0.1114	0.0		10.000	1.114		Vel = 16.57

Hyd. Ref. Point	Qa Qt	Dia. "C" Pf/Ft	Fitting or Eqv.	Ln.	Pipe Ftng's Total	Pt Pe Pf	Pt Pv Pn	******* Notes ******
A16	0.0	4.26		0.0	10.000	32.338		
to		120.0		0.0	0.0	0.0		
A17	735.96	0.1115		0.0	10.000	1.115		Vel = 16.57
A17	0.0	4.26	1T	26.334	1.000	33.453		
to		120.0		0.0	26.334	0.0		
A50	735.96	0.1115		0.0	27.334	3.047		Vel = 16.57
A50	0.0	6.357	4E	70.411	16.500	36.500		
to		120.0		0.0	70.411	2.166		
TOR	735.96	0.0159		0.0	86.911	1.378		Vel = 7.44
TOR	0.0	6.357		0.0	7.000	40.044		
to		120.0		0.0	0.0	8.032		* Fixed loss = 5
BOR	735.96	0.0159		0.0	7.000	0.111		Vel = 7.44
BOR	0.0	6.16	2E	40.168	220.000	48.187		
to		140.0	1T	43.037	87.509	0.433		
TEST	735.96	0.0139	1G	4.304	307.509	4.276		Vel = 7.92
	250.00							Qa = 250.00
	985.96					52.896		K Factor = 135.57